The National WIC Evaluation

An Evaluation of the Special Supplemental Food Program for Women, Infants, and Children

Volume II: Technical

Chapters I, II, III, References, and Appendixes to Chapter II

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THE NATIONAL WIC EVALUATION

Project Organization

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PREFACE

The evaluation of the Special Supplemental Food Program for Women, Infants and Children (WIC), designated here as the National WIC Evaluation, is a project undertaken by the Research Triangle Institute (RTI) under contract with the Office of Analysis and Evaluation, Food and Nutrition Service (FNS), United States Department of Agriculture (Contract No. 53-3198-9-87). The National WIC Evaluation is documented in this summary report and more comprehensively in four technical volumes: Volumes II and III - Technical Report and Volume IV and V - Appendixes. The summary report is written for the reader who wishes a brief nontechnical overview of the WIC program, an explanation of the logic of the National WIC Evaluation, and a discussion of its important results and conclusions. The technical report presents complete discussions of methodology, database construction, analysis techniques, results, and conclusions. The appendixes present copies of all data collection instruments used in the evaluation and supplementary tables referred to in the technical report.

This report covers the four component studies, namely the Historical Study of Pregnancy Outcomes, the Longitudinal Study of Pregnant Women, the Study of Infants and Children, and the Food Expenditures Study, upon which the National WIC Evaluation is based. These studies were designed primarily by the Principal Investigator, Dr. David Rush, with support from RTI staff and consultants, in the fall and winter of 1981-82. Dr. Rush's services, together with a small supporting staff, were made possible through a subcontract with the New York State Research Foundation for Mental Hygiene (NYRFMH).

Actual implementation of the studies began in the summer of 1982, with the major field data collection effort occurring during 1983. While RTI undertook major responsibility for organizing and managing the field effort, processing the data and preparing the basic data files, the entire effort was directed by Dr. Rush and carried out with support from his NYRFMH staff. The major analysis and reporting tasks were also carried out by Dr. Rush and his staff for three of the four component studies, with extensive support from RTI staff. The fourth study, concerned with food expenditures, was analyzed and the report prepared by RTI staff.

The success of the Historical Study was due in large part to the efforts of the State WIC program directors who, with their staff, provided annual counts of WIC women for individual clinics during the period 1974 to 1981. Considerable cooperation was also received from State directors of vital records who provided complete files of births and linked infant deaths for the period 1972 to 1980.

The Longitudinal Study, the Study of Children, and the Food Expenditures Study all acquired data through a national probability sample of pregnant women enrolled in the WIC program and a sample of low-income pregnant women not enrolled in WIC. The success of these samples and the success of the total data collection effort depended in no small part on the excellent cooperation of the directors and staff of the 174 WIC clinics and the directors and staff of the 55 non-WIC clinics that participated in the field phase of the study.

Both the study design and early drafts of this report were reviewed and critiqued by the FNS Advisory Panel to the National WIC Evaluation. The members of this Panel are listed on the inside cover.

The National WIC Evaluation received considerable support and valuable review and advice from the FNS Office of Analysis and Evaluation Project Officers Mr. David Shanklin and Dr. Burleigh Seaver. Particularly helpful were the review and comments of earlier drafts of this report by Dr. Seaver and by Ms. Nancy Chetry of the FNS Special Supplemental Food Division.

Finally, the consistently valuable, timely and able administration of the project by Ms. Sally Johnson is recognized.

D. G. Horvitz
Project Director

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I. INTRODUCTION

This chapter provides a summary description of the Special Supplemental Food Program for Women, Infants, and Children (WIC) and the objectives and logical structure of The National WIC Evaluation. Subsequent chapters describe each of the studies in detail that comprise The National WIC Evaluation and include all results and conclusions.

A. THE WIC PROGRAM

1. Description

WIC is a supplemental food program that operates as an adjunct to health care for low-income pregnant, postpartum, and breastfeeding women; infants; and children who are judged to be at nutritional risk. The program is based on the belief that improved nutrition and health care among infants, children, and pregnant and postpartum women will improve both the health status and the quality of life of participants and their families. The program is federally funded and State administered. Cash grants are made to authorized agencies of each State and to officially recognized Indian tribes or councils that then provide WIC services through local service sites. Priority for participation must be given by State agencies to geographic areas determined to need program benefits most. These include areas with documented high rates of infant mortality, low birthweight, and low income.

The provision of nutritious supplemental foods to targeted pregnant women in such areas is designed to improve the outcomes of pregnancy (i.e., increase weight gain in pregnancy, duration of gestation, and birthweight), which in turn should reduce fetal and infant mortality. For infants and children, the food supplements are intended to reduce the incidence of anemia and to improve both physical growth and cognitive development.

2. Legislative History

The 1969 White House Conference on Food, Nutrition, and Health recommended that special attention be given to the nutritional needs of pregnant women and preschool children. As an outcome of the conference, legislation authorizing the Special Supplemental Food Program for Women, Infants, and Children (WIC) was passed in 1972. Congress reported that "substantial numbers of pregnant, postpartum and breastfeeding women, infants and young children from families with inadequate income are at special risk with respect to their physical and mental health by reason of inadequate nutrition or health care, or both."

The WIC program was originally authorized (Public Law 92-433) as a 2-year pilot project to provide food supplements to pregnant, postpartum, and breastfeeding women; infants; and children up to age 4. The program has been reauthorized four times since its creation. It now includes children up to age 5 as program participants. Most recently, WIC operations have

been extended through Fiscal Year 1985. In 1974, the program served approximately 88,000 participants at an annual cost of $10.4 million. WIC has grown to serve an average of 3.5 million persons monthly during Fiscal Year 1984 at an annual cost of over $1.3 billion. WIC is now administered by 85 State agencies (of which 31 are Indian agencies), 1,500 local agencies, and 7,100 clinic sites.

3. Target Population

Program participation is open to pregnant women, postpartum women (up to 6 months after delivery), breastfeeding women (up to 12 months after delivery), infants (up to 1 year of age), and children (up to 5 years of age) from low-income families who are determined by a competent professional authority to be nutritionally at risk. The income-eligible population includes individuals whose gross income does not exceed 185 percent of the nonfarm poverty income defined in the Office of Management and Budget (OMB) guidelines. State WIC agencies have the option to set eligibility requirements from 100 to 185 percent of poverty, as long as income requirements correspond to income standards for free and reduced price health care.

The WIC program legislation (Public Law 95-627) defines nutritional risk as one or more of the following:

- Detrimental or abnormal nutritional conditions detectable by biochemical or anthropometric measurements.
- Other documented nutritionally related medical conditions.
- Dietary deficiencies that impair or endanger health.
- Conditions that predispose persons to inadequate nutritional patterns or nutritionally related medical conditions such as alcoholism and drug addiction.

Each State develops its own screening system that will identify participants who are at nutritional risk. At a minimum, however, a person's height and weight must be measured, and a test for anemia performed (e.g., hemoglobin, hematocrit, or free erythrocyte protoporphyrin test), except for infants under 6 months old. To ensure that program benefits are provided to eligible individuals who are at greatest nutritional risk, the program regulations have established six priority levels for program participants. Table I-1 describes the priorities of nutritional risk, outlined in Federal regulations.

Pregnant women are certified for WIC program benefits for the entire prenatal period and up to 6 weeks postpartum. At or before 6 weeks postpartum, women may be certified as either postpartum or breastfeeding. Once certified, postpartum women may remain on WIC until 6 months after delivery. Breastfeeding women are certified for 6-month periods, up to 1 year after delivery. Infants of women participating in WIC during pregnancy are

Table I-1

Priority System for Nutritional Risk Criteria

According to the WIC regulations, the following priorities are applied by the competent professional authority when vacancies occur after a local agency has reached its maximum participation level to ensure that those persons at greatest nutritional risk receive program benefits. State agencies may set income priority levels within these six priority levels.

Priority I

Pregnant women, breastfeeding women, and infants at nutritional risk as demonstrated by hematological or anthropometric measurements or other documented nutritionally related medical conditions that demonstrate the person's need for supplemental foods.

Priority II

Except those infants who qualify for Priority I, infants (up to 6 months of age) of WIC participants who participated during pregnancy and infants born of women who were not WIC participants during pregnancy but whose medical records document that they were at nutritional risk during pregnancy due to nutritional conditions detectable by biochemical or anthropometric measurements or other documented nutritionally related medical conditions that demonstrated the person's need for supplemental foods.

Priority III

Children at nutritional risk as demonstrated by hematological or anthropometric measurements or other documented medical conditions that demonstrate the child's need for supplemental foods.

Priority IV

Pregnant women, breastfeeding women, and infants at nutritional risk because of an inadequate dietary pattern.

Priority V

Children at nutritional risk because of an inadequate dietary pattern.

Priority VI

Postpartum women at nutritional risk.

Table I-2

WIC Participation

	Proportion of all WIC participation, FY 1980 (%)	Proportion of all WIC participation, FY 1984 (%)
Women	22	22
Infants	26	27
Children	52	51

Sources: Phase I Final Report (1981), The National WIC Evaluation. Food and Nutrition Service (1984).

given high priority for entrance into the program. Children may be certified up to their fifth birthday.

The proportions of WIC participants for women's, infants', and children's groups vary over time. Table I-2 provides the distribution of WIC participation for 1980 and 1984.

4. Program Benefits

The goal of the WIC program during pregnancy and the postpartum period, infancy, and early childhood is to improve participants' health by the provision of nutritious foods and nutrition education as an adjunct to good health care. The benefits provided by the WIC program are discussed below.

Supplemental Food

Each WIC participant is given a food "prescription" designed to provide specific nutrients known to be lacking in the diets of the target population. Foods high in protein, iron, calcium, Vitamin A, and Vitamin C (nutrients believed to be most often lacking in the diets of individuals at nutritional risk) are provided through one of several mechanisms. The participant may receive food directly from the local WIC agency, by home delivery, or more commonly through vouchers or checks that are exchanged for specific quantities of specified foods from retail food vendors. (These options are discussed in greater detail in Section 5, Delivery Systems.)

Legislation describes the types and quantities of foods available from WIC. As part of this legislative mandate, six separate food packages, specified in the program regulations (Federal Register, November 12, 1980), were developed for:

- Infants through 3 months of age.
- Infants 4 through 12 months of age.
- Children/women with special dietary needs.
- Children 1 to 5 years of age.
- Pregnant and breastfeeding women.
- Postpartum women not breastfeeding (see Table I-3).

State and local agencies may tailor the food prescription according to an individual participant's needs and can prescribe less than the maximum amounts for one food or more.

Nutrition Education

The role of nutrition education has changed during the history of the WIC program. The legislation that established WIC on a pilot basis in 1972 had no provision for nutrition education. However, some WIC programs even then provided nutrition counseling as an additional service.

When WIC was reauthorized in October 1975, nutrition education was mandated on a national basis. In the current legislation, the provision for nutrition education was expanded. According to the regulations for implementing Public Law 95-627, nutrition education should "(1) Emphasize the relationship between proper nutrition and good health, with special emphasis on the nutritional needs of pregnant, postpartum, and breastfeeding women, infants and children under five years of age; and (2) Assist the individual who is at nutritional risk in achieving a positive change in food habits, resulting in improved nutritional status and in the prevention of nutrition-related problems through optimal use of the supplemental food and other nutritious foods."

The current WIC legislation mandates that at least one-sixth of the funds expended by the State agency for administrative costs be spent for nutrition education. The regulations require a minimum of two nutrition education contacts between the participant and the WIC local agency during each 6-month certification period.

The nutrition education available through WIC projects varies in method, frequency, style, and provider. Common forms of nutrition education include counseling, group sessions, and provision of written materials. Dietitians and nutritionists are major providers of nutrition education. However, physicians, nurses, aides, and clerks also may be responsible for nutrition education.

Adjunct to Health Care

An expected indirect benefit of WIC for women, infants, and children should be the increased and regular utilization of health care services.

Table I-3

Maximum Quantity of Supplemental Food Authorized per Month

(1) Food Package I--Infants 0 through 3 Months

Food	Quantity
Formula:	
Concentrated liquid formula	403 fluid oz (11.9 L)
or	
Powdered formula	May be substituted at the rate of 8 lb (3.6 kg) per 403 fluid oz (11.9 L) of concentrated liquid formula
or	
Ready-to-feed formula	May be substituted at the rate of 26 fluid oz (.8 L) per 13 fluid oz (.4 L) of concentrated liquid formula

(2) Food Package II--Infants 4 through 12 Months

Food	Quantity
Formula:	
Concentrated liquid formula	403 fluid oz (11.9 L)
or	
Powdered formula	May be substituted at the rate of 8 lb (3.6 kg) per 403 fluid oz (11.9 L) of concentrated liquid formula
or	
Ready-to-feed formula	May be substituted at the rate of 26 fluid oz (.8 L) per 13 fluid oz (.4 L) of concentrated liquid formula
Infant cereal	24 oz dry (.7 kg)
Juice:[a]	
Single-strength adult juice	92 fluid oz (2.7 L)

Footnotes at end of table.

(continued)

Table I-3 (continued)

(2) Food Package II--Infants 4 through 12 months (continued)

Food	Quantity
Juice:[a] (continued)	
or	
Frozen concentrated juice	96 fluid oz reconstituted (2.8 L)
or	
Infant juice	May be substituted at the rate of 63 fluid oz (1.9 L) of infant juice per 92 fluid oz (2.7 L) of single strength adult juice

(3) Food Package III--Children/Women with Special Dietary Needs

Food	Quantity
Formula:	
Concentrated liquid formula	403 fluid oz (11.9 L)
Addition[b]	52 fluid oz (1.5 L)
or	
Powdered formula	May be substituted at the rate of 8 lb (3.6 kg) per 403 fluid oz (11.9 L) of concentrated liquid formula
Addition[b]	1 lb (.4 kg)
or	
Ready-to-feed formula	May be substituted at the rate of 26 fluid oz (.8 L) per 13 fluid oz (.4 L) of concentrated liquid formula
Addition[b]	104 fluid oz (3.1 L)
Cereal (hot or cold)	36 oz dry (1 kg)
Juice:[a]	
Single-strength juice	138 fluid oz (4.1 L)
or	
Frozen concentrated juice	144 fluid oz reconstituted (4.3 L) juice

Footnotes at end of table.

(continued)

Table I-3 (continued)

(4) Food Package IV--Children 1 to 5 Years

Food	Quantity
Milk:	
Fluid whole milk	24 qt (22.7 L)
or	
Fluid skim or low-fat milk	May be substituted for fluid whole milk on a quart-for-quart (.9 L) basis
or	
Cultured buttermilk	May be substituted for fluid whole milk on a quart-for-quart (.9 L) basis
or	
Evaporated whole milk	May be substituted for fluid whole milk at the rate of 13 fluid oz (.4 L) per quart (.9 L) of fluid whole milk
or	
Evaporated skimmed milk	May be substituted for fluid whole milk at the rate of 13 fluid oz (.4 L) per quart (.9 L) of fluid whole milk
or	
Dry whole milk	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 3 qt (2.8 L) of fluid whole milk
or	
Nonfat or lowfat dry milk	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 5 qt (4.7 L) of fluid whole milk
or	
Cheese	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 3 qt (2.8 L) of fluid whole milk. 4 lb (1.8 kg) is the maximum amount that may be substituted[c]

Footnotes at end of table.

(continued)

Table I-3 (continued)

(4) Food Package IV--Children 1 to 5 Years (continued)

Food	Quantity
Eggs:	
Fresh eggs	2 doz or 2½ doz
or	
Dried egg mix	May be substituted at the rate of 1.5 lb (.7 kg) egg mix per 2 doz fresh eggs or 2 lb (.9 kg) egg mix per 2½ doz fresh eggs
Cereal (hot or cold)	36 oz dry (1 kg)
Juice:[a]	
Single-strength juice	276 fluid oz (8.2 L)
or	
Frozen concentrated juice	288 fluid oz reconstituted (8.5 L)
Legumes:	
Dry beans or peas	1 lb (.4 kg)
or	
Peanut butter	18 oz (.5 kg)

(5) Food Package V--Pregnant and Breastfeeding Women

Food	Quantity
Milk:	
Fluid whole milk	28 qt (26.5 L)
or	
Fluid skim or low-fat milk	May be substituted for fluid whole milk on a quart-for-quart (.9 L) basis
or	
Cultured buttermilk	May be substituted for fluid whole milk on a quart-for-quart (.9 L) basis
or	
Evaporated whole milk	May be substituted for fluid whole milk at the rate of 13 fluid oz (.4 L) per quart (.9 L) of fluid whole milk

Footnotes at end of table. (continued)

(5) Food Package V--Pregnant and Breastfeeding Women (continued)

Food	Quantity
Milk (continued):	
or	
Evaporated skimmed milk	May be substituted for fluid whole milk at the rate of 13 fluid oz (.4 L) per quart (.9 L) of fluid whole milk
or	
Dry whole milk	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 3 qt (2.8 L) of fluid whole milk
or	
Nonfat or low-fat dry milk	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 5 qt (4.7 L) of fluid whole milk
or	
Cheese	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 3 qt (2.8 L) of fluid whole milk. 4 lb (1.8 kg) is the maximum amount that may be substituted[c]
Eggs:	
Fresh eggs	2 doz or 2½ doz
or	
Dried egg mix	May be substituted at the rate of 1.5 lb (.7 kg) egg mix per 2 doz fresh eggs or 2 lb (.9 kg) egg mix per 2½ doz fresh eggs
Cereal (hot or cold)	36 oz dry (1 kg)
Juice:[a]	
Single-strength juice	276 fluid oz (8.2 L)
or	
Frozen concentrated juice	288 fluid oz reconstituted (8.5 L)
Legumes:	
Dry beans or peas	1 lb (.4 kg)
or	
Peanut butter	18 oz (.5 kg)

Footnotes at end of table

(continued)

Table I-3 (continued)

(6) Food Package VI--Nonbreastfeeding Postpartum Women

Food	Quantity
Milk:	
Fluid whole milk	24 qt (22.7 L)
or	
Fluid skim or low-fat milk	May be substituted for fluid whole milk on a quart-for-quart (.9 L) basis
or	
Cultured buttermilk	May be substituted for fluid whole milk on a quart-for-quart (.9 L) basis
or	
Evaporated whole milk	May be substituted for fluid whole milk at the rate of 13 fluid oz (.4 L) per quart (.9 L) of fluid whole milk
or	
Evaporated skimmed milk	May be substituted for fluid whole milk at the rate of 13 fluid oz (.4 L) per quart (.9 L) of fluid whole milk
or	
Dry whole milk	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 3 qt (2.8 L) of fluid whole milk
or	
Nonfat or low-fat dry milk	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 5 qt (4.7 L) of fluid whole milk
or	
Cheese	May be substituted for fluid whole milk at the rate of 1 lb (.4 kg) per 3 qt (2.8 L) of fluid whole milk. 4 lb (1.8 kg) is the maximum amount that may be substituted[c]

Footnotes at end of table. (continued)

(6) Food Package VI--Nonbreastfeeding Postpartum Women (continued)

Food	Quantity
Eggs:	
Fresh eggs	2 doz or 2½ doz
or	
Dried egg mix	May be substituted at the rate of 1.5 lb (.7 kg) egg mix per 2 doz fresh eggs or 2 lb (.9 kg) egg mix per 2½ doz fresh eggs
Cereal (hot or cold)	36 oz dry (1 kg)
Juice:[a]	
Single-strength juice	184 fluid oz (5.4 L)
or	
Frozen concentrated juice	192 fluid oz reconstituted (5.7 L)

[a]Combinations of single-strength and frozen concentrated juice may be issued as long as the total volume of juice does not exceed the amount specified for single-strength juice.

[b]Additional formula may be issued on an individual basis provided the need is demonstrated and documented in the individual's certification file by the competent professional authority.

[c]Additional cheese may be issued on an individual basis in cases of lactose intolerance provided the need is documented in the participant's file by the competent professional authority.

Although services are not paid for with WIC funds, the WIC program is expected to encourage the utilization of existing health services. In this way, the WIC program links the participant and appropriate health care. Program regulations require local agencies to make health care available to all participants. Health services are defined in the regulations as: "ongoing, routine pediatric and obstetric care (such as infant and child care and prenatal and postpartum examinations) or referral for treatment."

5. Delivery Systems

Three basic types of systems are used by States to deliver foods to WIC participants: retail purchase, home delivery, and direct distribution.

States operate their own variations of these systems. In 1983, 89 percent of WIC participants nationwide received food through the retail purchase system. In this system the participant receives from the WIC agency a food instrument (FI)--in the form of a check or voucher--that prescribes specific quantities of specific foods. The participant redeems FIs at an authorized retail vendor, usually a grocer, who is then paid by the State agency. When the FI is a bank check, the vendor deposits it in his/her own bank account. When the FI is a voucher, the vendor submits it directly to the State for reimbursement. In a home delivery system, the WIC agency contracts with a vendor, often a dairy, which delivers the prescribed food to the participant's home. In 1983, 8 percent of all WIC participants were served by this system. In a direct distribution system, the WIC agency purchases food, often on the wholesale market, and the WIC agency stores and distributes the food to participants directly. In 1983, 3 percent of all WIC participants used this system.

6. Program Administration

The WIC program is administered by the Supplemental Food Programs Division of the Food and Nutrition Service (FNS) as a grant-in-aid program that allocates funds directly to State health departments and Indian tribal agencies. Those agencies are responsible for operating the program within their jurisdictions. Benefits to program participants are provided through local WIC agencies and clinics. The WIC program allows significant latitude to States and local agencies in the provision of WIC services. The range and type of local service providers (e.g., hospitals, churches, and county health departments) may vary as may the system of State administration and management; the food delivery systems; the participant certification requirements (within Federal guidelines); the tailoring of food package contents; and food instruments. Thus, each State (and each local agency) has many managerial options, within the bounds of Federal requirements and guidelines. A brief discussion of the different Federal, State, and local responsibilities is provided below.

Federal

The USDA, through the headquarters and regional offices of the Supplemental Food Programs Division, FNS, is responsible for administering the WIC program consistent with program legislation and regulations. The WIC program operates through cash grants, on a formula basis, to State health departments or comparable State agencies. These agencies distribute funds to the participating local agencies. Twenty percent of the funds provided nationally can be used for State and local administrative costs. Research support is provided through the FNS Office of Analysis and Evaluation, which was responsible for the support of the National WIC Evaluation.

State

To qualify for Federal funds, each State agency is required to submit a State plan annually to FNS. Approval of the plan by FNS is a prerequisite to the payment of funds to the State agency. The State agency plan

must include the identification of areas within the State that most need the program and a plan to address those needs. This should include discussion and justification of criteria used to rank various areas in the State. The State plan is the document that provides Washington and regional offices with a description of State program operations and identifies the program's unique features.

State agencies are responsible for developing specific nutritional risk criteria (see Table I-1) and for ensuring that these criteria are applied to certify the eligibility of individuals at local WIC sites. State agencies have direct responsibility for review and approval of local agencies' applications to operate the WIC program, based on the priority system for selecting local WIC grantees, which is detailed in the regulations. State agencies also are responsible for monitoring local projects and for ensuring that adequate nutrition education services are provided within the State.

Local

Any public or private, nonprofit health or human service agency can apply to the State to operate a WIC program if it can make health services available to participants. Once funded, the local WIC agency is responsible for day-to-day program operations including certification of eligible participants, provision of nutrition education, implementation of a delivery system for the food supplements as prescribed by the State agency, and administrative and fiscal reporting.

B. OBJECTIVES OF THE EVALUATION

1. Overview

Congress allocated funds to evaluate the WIC program in its reauthorization of WIC in 1978 (Public Law 95-627). This authorization reflected a growing understanding of the need for a formal national evaluation of WIC on the part of decisionmakers at several levels of government. As an outgrowth of this legislation, the Food and Nutrition Service contracted with Research Triangle Institute (RTI) in October 1979 to conduct a comprehensive evaluation of the WIC program.

2. General Objectives

The primary objective of The National WIC Evaluation has been to assess the WIC program's impact on the health and nutritional status of its participants. The study's evaluation objectives were specified by FNS to include:

- Assess the effects of the WIC intervention on pregnant women, including measures of pregnancy outcomes, nutritional status, dietary intake, and health care utilization.

- Assess the effects of WIC intervention on children, including measures of growth, dietary intake, health care utilization, and psychological and emotional development.

- Describe the characteristics of WIC participants who benefit most from WIC intervention.

- Determine the degree to which WIC foods substitute for foods that would have been purchased without the program or are shared with family members.

C. LOGICAL STRUCTURE OF THE EVALUATION

1. Introduction

The National WIC Evaluation consisted of a series of activities conducted over a 5-year period. A set of predesign activities provided the descriptive, informational, and conceptual basis for the evaluation design. These activities included determining the information needs of the primary audiences for the evaluation and reviewing literature relevant to WIC operations and possible evaluation methodologies. Another preliminary activity consisted of telephone interviews to all operating WIC agencies to obtain descriptive data on program participation and operations. These activities and the results were presented in the 1982 FNS document, Phase I Final Report.*

Next, instruments and procedures to measure health and nutrition impacts were developed and field tested. The results of a 5-week field test at three sites further contributed to the field study designs. Based on these results and extensive discussions with FNS, it became obvious that several simultaneous research strategies were required to meet the objectives of The National WIC Evaluation.

Four studies were designed to be conducted concurrently. The first two studies addressed the effects of the WIC intervention on pregnant women and newborn infants. The third assessed the effects of WIC on children, and the fourth evaluated the economic impact of WIC program benefits. In addition to these studies, a comprehensive review of all previous WIC research was undertaken to place the findings of the current studies in a secure historical context.

2. Review of Previous WIC Research

The review of previous WIC research has several objectives. The first is to provide a critical and detailed review of the current state of knowl-

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*Available from National Technical Information Service, Springfield, Virginia, Acquisition Number PB83200915; Executive Summary, Acquisition Number PB83252320.

edge of the health effects of the WIC program. Past reports have either been limited to one or a few research projects or have not probed how limitations of study design, execution, or analysis might influence both the direction and security of conclusions. Second, it is essential to the interpretation of The National WIC Evaluation to be able to place them in the context of past work. The meaning of current findings will be influenced by their coherence and consistency with past work. Finally, this review allows gaps in knowledge to be identified in order to direct future research and evaluation.

3. Historical Study of Pregnancy Outcomes

The Historical Study addresses the question of whether rates of various birth outcome measures were changed in communities by the presence of WIC during the first 9 years of its operation (1972 to 1980). Research measures included:

- Adequacy of prenatal care.
- Fetal mortality.
- Infant mortality.
- Duration of gestation.
- Birthweight.

Thus, the effect of WIC was assessed at the community rather than the individual level and within population strata likely to have received WIC benefits. Benefits were related to the level of service of the local WIC program (i.e., the numbers of women served in an area relative to an estimate of the total number eligible [penetration]). This approach provides an estimate of the community and societal impact of the WIC program on a national level. In contrast to the other three studies, which rely on primary data, the Historical Study is based on WIC program data provided by State personnel and on State vital statistics covering the 9-year study period.

4. The Longitudinal Study of Pregnant Women

The primary objective of the Longitudinal Study of Pregnant Women is to assess the effects of the WIC intervention on both the mother and newborn. Maternal outcomes included:

- Utilization of prenatal care.
- Weight gain during pregnancy.
- Dietary intake including food consumption patterns and nutrient intake.

- Maternal energy storage and deposition.

- Maternal health behavior, including smoking and alcohol use.

- Duration of gestation.

- Breastfeeding.

The newborn outcomes included:

- Birthweight.

- Birth length and head circumference.

- Morbidity.

- Mortality.

In addition, the study attempted to identify pregnant women who were more likely to benefit from WIC.

The basic design of the Longitudinal Study was a comparison of pregnant WIC participants and controls, with assessment of all three components of WIC intervention (food supplementation, nutrition education, and coordination of health care). The design of the study permitted assessment of longitudinal change in diet, maternal weight gain, and skinfold thickness, all of which were related to birth outcome. The WIC study sample was nationally representative of the program population.

5. The Study of Infants and Children

The primary objective of the Study of Infants and Children is to assess the effects of WIC intervention on:

- Dietary intake, including food consumption patterns and nutrient intake.

- Child growth, including weight, height, arm circumference and skinfold thickness, as well as prevalence of underweight, obesity, and growth retardation.

- Child behavior, vocabulary, and memory.

- Use of preventive health care services, including immunizations and well child care.

Another objective was to describe the characteristics of children who were most likely to benefit from WIC intervention.

In contrast to the Longitudinal Study of Pregnant Women, the Study of Infants and Children is cross-sectional. It assessed the effects of WIC

benefits on infants and preschool children of the women selected for the Longitudinal Study of Pregnant Women. By comparing children currently participating in WIC with those who previously participated and those who never participated, this design allowed estimates to be made of how WIC affects the diets, health, growth, and development of children.

6. The Food Expenditures Study

The primary objective of this study is to assess the degree to which foods provided by WIC:

- Supplement rather than substitute for foods that would have been purchased by the WIC household.

- Are consumed by the WIC participant rather than by other members of the household.

Cumulative research experience on food distribution programs suggests that not all of the food that is distributed to program participants reaches the intended target--either due to sharing with others or due to the displacement of food that otherwise would have been consumed (substitution). This appears to be almost inevitable in such programs. An assessment of the extent of both substitution and sharing in the national WIC program is an important component of the evaluation. Such an assessment addresses the efficiency with which food reaches the intended beneficiary and the potential gaps between the delivery and consumption of WIC foods. This may help explain differences in the strength of WIC effects among certain groups of participants, among different types of programs, or along other policy-relevant parameters.

The Food Expenditures Study combined the use of recall and diary methods to collect data on household food expenditures in each of two interviews with WIC participants and controls in the Longitudinal Study of Pregnant Women. The data collection design permitted longitudinal and cross-sectional comparisons between WIC and non-WIC (or control) households on total food expenditures as well as cross-sectional comparisons on detailed food purchases at the time of the second interview (late in the pregnancy).

D. ORGANIZATION OF THE REPORT

The technical report of The National WIC Evaluation is presented in Volumes II and III. The remainder of this volume describes, by chapter, the logical sequence of this evaluation. Chapter II provides the Review of Previous WIC Research. The Historical Study of Pregnancy Outcomes is described in Chapter III, including the rationale for the study, a description of data acquisition and analytic methods, and a description of findings and conclusions. Chapter IV provides a full description of the methodology for collection of primary data used in the Longitudinal Study of Pregnant Women, the Study of Infants and Children, and the Food Expenditure

study. Chapters V, VI, and VII present the rationale, analytic methods, and results of these three studies, respectively. Volume III concludes with a complete reference list, Chapter VIII. Because the results of the studies are extensive, including much data, supportive documentation is included in detailed Appendixes in Volumes IV and V.

II. EVALUATIONS OF PAST WIC STUDIES

A. INTRODUCTION

This chapter has several purposes; the first is to make available a technically detailed critical review of the WIC program's health effects at the onset of this national evaluation. Past reviews have been limited to one or a few research projects or have not probed how limitations (whether inherent or imposed by the investigators) of study design, execution, or analysis influence the direction and security of conclusions. Second, it is essential for interpreting results of the current evaluation studies to place them in the context of past work. The meaning of current findings is influenced by their coherence and consistency with past work. Finally, this overview identifies gaps in knowledge to direct future research and evaluation.

This chapter consists of five components, each reviewing a central effect of the WIC program: birthweight, perinatal and infant survival, anemia, somatic (physical) growth in infancy and childhood, and dietary intake. These are followed by a short summary. A detailed, critical review of each study and an abstract of key data for each are included in the Chpater II appendixes in this volume (see Appendix II-A). The appendices include abstracts and reviews of studies that address issues other than the central issues under review (Appendix II-B) and several received after the initial review was completed (Appendix II-C).* Abstraction of data from and description of the individual studies reflect the effort of the evaluation team; the summaries and conclusions are the responsibility of the Principal Investigator. The bibliography (Appendix II-D) has been coordinated with several sources, including (1) the Office of Analysis and Evaluation of the Food and Nutrition Service (FNS); and (2) Ms. Christine Fossett and other staff at the U.S. General Accounting Office (GAO), who have recently completed a review of past WIC evaluations on request from the Senate Committee on Agriculture (GAO, 1984). The studies summarized by Research Triangle Institute (RTI) as part of its initial work in The National Evaluation of the WIC Program (RTI, 1981) were reviewed based on original documents whenever possible and not on interpretations or conclusions of past reviews, since the aim was a fresh and independent appraisal of this body of knowledge.

B. BIRTHWEIGHT DIFFERENCES ASSOCIATED WITH WIC BENEFITS DURING PREGNANCY

1. Introduction

Table II-1 includes summarized results of 21 individual studies, each abstracted and reviewed in detail in Appendix II-A. In each study a dif-

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*The five additional studies came to notice between January and May 1984 (Appendix II-C). Only one of these included extensive information on how participation in the WIC program affects health or nutritional status. Relevant data were abstracted in Table B-4, included in Appendix II-B.

Table II-1

Summary: Reported Birthweight Differences Associated With WIC Benefits During Pregnancy

Authors	Difference in birthweight (g)	Difference in % <2,500 g birthweight	n, subjects	n, controls
Medicaid or postpartum WIC controls				
Edozien et al. (1976a, 1976b; 1979)	102* or 136*	NA	139	41
	NA	-2.0**	1,651	4,976
	Comment: Two regression models for mean birthweight: 6+ months WIC treatment in pregnancy vs. postnatal WIC recruits; relationship of duration of WIC benefits to mean birthweight confounded by duration of gestation. Postpartum WIC recruits were controls.			
Fleshood et al. (1983)	NA	-5.9***	12,533	7,961
	Comment: Tennessee, all 1982 prenatal WIC recipients vs. postnatal WIC recruits.			
Goldberg (1982)	368***	-17.6	46	63
	Comment: Prenatal vs. postnatal WIC recruits. Results confounded to the extent that low birthweight was the criterion for postnatal recruitment into WIC.			
Heimendinger (1981)	60*	NA	476	1,536
	Comment: Three WIC sites in Boston; controls: postnatal WIC recruits (438) and children at neighborhood clinics (1,098). Difference controlled for whether low birthweight/premature, probably leading to underestimate of true difference.			
Kennedy et al. (1982)	122*** or 60*	-2.8*	897	400
	Comment: Lower figure for mean birthweight adjusted for social and biological differences between WIC and control groups. Comparability of WIC group and controls (e.g., race) not fully established.			

(continued)

Table II-1 (continued)

Authors	Difference in birthweight (g)	Difference in % <2,500 g birthweight	n, subjects	n, controls
Langham et al. (1975; addendum 1981)	NA	-4.8***	11,817	6,214
	Comment: Controls: postpartum WIC recruits; Louisiana WIC program, 1979-81.			
Schramm (1983)	6	-1.9*	1,883	5,745
	Comment: Medicaid births, Missouri, 1980.			
Williams (1982)	NA	-5.1**	506	750
	Comment: Prenatal vs. postnatal WIC recruits, Wyoming, 1978-80.			
Community or other controls				
Bailey et al. (1983)	-47	-5.0	35	46
	Comment: WIC group from one Maternal and Infant Care (MIC) project. Controls from public clinic; controls reported greater calorie intake.			
Brevard County, Florida (1977)	NA	-5.5	NA	NA
	Comment: Total n = 1,847; countywide data pre-WIC and post-WIC.			
Centers for Disease Control (CDC) (1978)	NA	-3.6***	1,580	20,257
	Comment: Louisiana WIC recipients vs. Charity Hospital, New Orleans.			
	NA	-1.8*	2,126	6,944
	Comment: North central Florida WIC recipients vs. births prior to WIC.			
Collins et al. (1981)	0	2.6	342	178
	Comment: Study among those receiving prenatal care in six Alabama Appalachian county health departments.			

(continued)

Table II-1 (continued)

Authors	Difference in birthweight (g)	Difference in % <2,500 g birthweight	n, subjects	n, controls
Kotelchuck et al. (1981)	21	-1.9**	4,126	4,126
	Comment: Massachusetts, 1978, WIC recipients matched with controls on several characteristics known from birth certificates.			
Kotelchuck et al. (1982)	28	-1.7*	1,309	1,309
	Comment: Subset of same study population, comparing differential increase in birthweight and rates of low birthweight across pregnancies.			
Metcoff et al. (1982)	-146	NA	63	37
	Comment: Lowest tercile, predicted birthweight.			
	-14	NA	83	101
	Comment: Middle tercile, predicted birthweight.			
	111	NA	92	34
	Comment: Upper tercile, predicted birthweight.			
Total	-4	1.8		
	Comment: Total population.			
Nutt et al. (1981)	72**	NA	104	104
	Comment: WIC and "matched" control group widely discrepant for race and welfare status. Results not controlled for infants' sex; sex differences could account for about 12 g of difference between WIC recipients and controls.			
Rye et al. (1978a)	NA	-0.9 0.3	1976-7: 1,360 1977-8:	All births in Arizona, 1977
	Comment: All WIC recipients in 14 counties and 9 tribal WIC programs in Arizona, vs. statewide rates.			

(continued)

Table II-1 (continued)

Authors	Difference in birthweight (g)	Difference in % <2,500 g birthweight	n, subjects	n, controls
Schelzel and Britton (1978)	NA	-5.3	64 (<6 months benefits)	-
		-10.5	55 (≥6 months benefits)	-
	Comment: Comparison with past reproductive history. Results confounded by regression to the mean, if adverse past outcome a criterion for program eligibility.			
Sharbaugh et al. (1977)	57*	NA	452	222
	Comment: MIC recipients, central Florida; 6 counties with WIC, 3 without, 1975-76.			
	NA	-1.8*	2,126	6,994
	Comment: MIC recipients, central Florida; comparison of rates before (≤1974) and after (1975-1976) the introduction of WIC.			
Silverman et al. (1982)	94***	-3.3*	1,047	1,361
	Comment: MIC recipients, Alleghany County, Pennsylvania; most controls prior to WIC program (1974).			
Stockbauer and Blount (1983)	16*	-0.9*	6,657	71,931
	(Nonwhite: 48*	-3.1*	2,200	NA)
	Comment: All births, Missouri, 1980; results controlled for maternal weight at conception, smoking, education, and race.			

*p < 0.05.
**p < 0.01.
***p < 0.001.

ference in mean birthweight, a difference in the rate of birthweight under 2,500 grams, or both were available between WIC recipients and controls. In one study (Schelzel and Britton, 1978), comparison was with the WIC recipients' past history, rather than with that of a control population.

These studies are divided into two groups: those in which controls were either women who registered for WIC benefits postpartum or were Medicaid recipients not registered for WIC, and those in which community or other controls were used. In studies where postpartum WIC recruits or Medicaid recipients were controls, these controls may have been at greater risk of adverse perinatal outcome than prenatal WIC recipients; however, controls drawn from the community are in all likelihood at lower risk than WIC recipients (other than in the study of Metcoff et al. [1982], where subjects were allocated randomly either to receive WIC benefits or not).

There are three reasons for assuming that WIC recipients recruited after delivery are likely to have infants of low birthweight, relative to prenatal WIC recipients but independent of any effects of the WIC program. First, low infant birthweight may have been one of the recruitment or certification criteria that facilitated postpartum entry into the program. Because low birthweight may have led to inclusion in the control group, any comparison with their birthweight is flawed. Second, among control women who delivered prematurely, had they not done so, it is possible that they might have joined the WIC program later in pregnancy. Thus, some sort of life table analysis or retrospective cohort design would be needed to account for the bias that results from those who delivered very preterm without the chance to join the program. Third, postpartum recruits were, by definition, both of low income and at nutritional or health risk and therefore certifiable for WIC; but possibly they had not sought benefits prior to delivery. This suggests that they may be behaviorally different from prenatal recipients (i.e., less aggressive, less competent, or less interested in acquiring benefits for which they most likely would have been eligible). Thus, a comparison between prenatal WIC recipients and those recruited after pregnancy is likely to overestimate program effect, all other things being equal. (The study of Heimendinger [1981] was included in this group because the control group in the analysis for birthweight included postpartum WIC recruits in addition to neighborhood controls drawn from local clinics, who were almost all receiving Medicaid.)

The argument that controls drawn from Medicaid rosters are possibly worse off than the average WIC recipient is not as strong. The economic limits for Medicaid eligibility are generally more stringent than for WIC. Thus, using Medicaid births as controls for WIC recipients is probably biased in favor of WIC births. However, this would not be true for studies where <u>both</u> the WIC and control groups are drawn from lists of Medicaid recipients (i.e., the study by Schramm [1983] of all Medicaid births in Missouri in 1980).*

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*In the Longitudinal Study of Pregnant Women, the likelihood that a control or WIC woman was enrolled in Medicaid was nearly identical (Volume III, Chapter V), while for almost all other indices the control group was far more privileged. Women receiving Medicaid and WIC may thus be less privileged than those receiving Medicaid alone.

On the other hand, community controls, all other things being equal, would tend to be at lower risk of adverse perinatal outcome than WIC recipients. Only in the randomized trial of Metcoff et al. (1982) was it certain that such controls met the income and nutritional or health risk criteria for WIC eligibility. Thus, however well matched WIC recipients and controls might be on race, age, or parity, WIC recipients would likely be of lower income and at greater health or nutritional risk. In general, investigators did not or were unable to test whether the study groups were comparable for unmatched characteristics.

It is thus assumed that studies using community or other controls would tend to underestimate effects of the WIC program, all other things being equal. (It appears that this assumption holds much more strongly for whites than for blacks or other minority women. The residual of minority births not receiving WIC benefits does not seem to be systematically at lower risk than WIC recipients. Either they are at higher initial risk or the effects of the program are so great among these women that they emerge clearly, even if controls were at lower risk.)

2. Studies Where Controls Were Either Postpartum WIC Recruits or Received Medicaid Benefits

Results for the group of studies where postnatal WIC recruits or Medicaid recipients were controls are presented in Table II-1. Results of the small study of Goldberg, a medical student project, are out of range of the other studies. For the seven other studies, four report statistically significant differences in mean birthweight and six report differences in proportions of low birthweight. The lowest estimated mean birthweight difference was an increment of 6 grams in the large study of Schramm (1983), who studied all Medicaid births in Missouri in 1980. The greatest differences were 136 or 102 grams (from two different regression models, for the same study group) estimated by Edozien et al. (1976a,b; 1979), who compared birthweights of infants of a few postnatal recruits to birthweights of infants of mothers who had received benefits for 6 months or longer during pregnancy (this comparison was confounded by duration of gestation) and 122 or 60 grams by Kennedy et al. (1982) (the lower estimate was controlled for social and biological differences between WIC and control groups). Heimendinger (1981) also estimated a 60-gram increase. Heimendinger's results may have been an underestimate because she controlled for low birthweight or preterm delivery in analysis. Thus, the relationship of WIC benefits in pregnancy to mean birthweight, with Medicaid recipients or postpartum WIC recruits as controls, ranged from 6 to about 100 grams: three large studies, all with analytic or design flaws, estimated between 60 and 102 grams and one large, relatively more reliable study estimated 6 grams.

The difference in rate of low-birthweight delivery between WIC recipients and controls (again excluding the small study of Goldberg) ranges from a 1-percent reduction among short-term WIC recipients in the study of Langham et al. (1975) to a 5.9-percent reduction for all WIC recipients in Tennessee in 1980 (Fleshood et al., 1983). The reduction of 1.9 percent

observed by Schramm among Medicaid births in Missouri in 1980 contrasts with the reduction of 0.9 percent for the total Missouri population in the same year (after control for maternal weight at conception, smoking, education, and race; Stockbauer and Blount, 1983).

This set of results remains problematic for the same reasons as for estimates of difference in mean birthweight. Postnatal WIC infants are so likely to be at systematically higher risk than prenatal WIC infants that the studies using them as controls, as a group, are highly suspect.

3. Studies With Community or Other Controls

Thirteen studies reported differences either in mean birthweight or in frequency of low birthweight and used a variety of other control groups. Differences in mean birthweight were reported in nine of these studies and differences in rate of low birthweight in all but one. Several of these studies were very small and some used very nonspecific strategies, such as the Brevard County, Florida (1977), study, where countywide rates were compared before and after the introduction of WIC programs. The range of differences in mean birthweight reported by the authors went from a negative relationship of 146 grams for infants predicted to be of lowest birthweight in the study of Metcoff et al. (1982) to a positive relationship of 94 grams in the study of all MIC project recipients around Pittsburgh using (mostly) controls born prior to the start of the local WIC program or the 111-gram increment observed by Metcoff et al. in the subgroup of low-risk subjects (those predicted to have infants of highest birthweight).

In the study of Stockbauer and Blount (1983) of all 1980 births in Missouri and in the study of Kotelchuck et al. (1981, 1982) of most 1978 WIC births with matched controls in Massachusetts, despite matching or analytic control it is likely that the controls did not have such low incomes or the same level of health or nutritional risk as WIC recipients. In all likelihood, therefore, both the increment in birthweight estimated by Stockbauer and Blount (16 grams) and the 0.9-percent reduction in the rate of low birthweight are low, as is the birthweight difference of 21 grams observed by Kotelchuck et al. In both studies, there may be a systematic deficit in the proportion of very low-birthweight deliveries (under 1,500 grams) in the WIC population because women terminated by the WIC program were excluded from the WIC study group, since one of the grounds for termination was not returning twice for WIC vouchers. Thus, if a woman delivered prematurely, she might have been classified as a program dropout and the result would be a deficit in premature births. If both factors (under-control and exclusion of preterm deliveries) were operating, they would have had opposite effects and it is impossible to quantify their joint effect unless the investigators are able to present outcome for terminated cases. The negative relationship between WIC benefits and birthweight among those at highest risk in the randomized study of Metcoff et al. was not statistically significant and may be a function of chance variation that followed from the very small sample size, with consequent low power to test for program effect.

Results among nonwhites in Missouri in 1980 (Stockbauer and Blount, 1983), for whom there was a 48-gram advantage among WIC births and a 3.1-percent reduction in rate of low birthweight, are provocative. In the nonwhite community, enrollment in the WIC program may not be associated with higher risk, or possibly effects were so great that they showed strongly despite initial noncomparability. These results are important; it would be valuable to be able to replicate this study for years other than 1980 and to assess whether other risk factors such as marital status, parity, and maternal age (and, while not available from vital statistics, maternal infection) are comparable in the WIC and control groups. It would be helpful to know if the definition of WIC included all women initially certified or excluded those terminated for such reasons as not returning twice for vouchers.

Differences in the proportion of low-birthweight births among WIC recipients range from an excess of 5 percent in the small study of Bailey et al. (1983) and an excess of 2.6 percent by Collins et al. (1981) in six Alabama Appalachian region counties, to as much as 3.1 percent lower among nonwhite WIC recipients in Missouri in 1980 (Stockbauer and Blount, 1983) or 3.3 percent among MIC recipients who received WIC benefits, compared to other MIC recipients in Pittsburgh (Silverman et al., 1982). The large differences observed in the small study of Schelzel and Britton (1978), comparing women with their own past histories, are suspect, given the possibility that adverse past reproductive history may have led to enrollment and certification in the program or may have been exaggerated to gain entry into the program. The large reduction in the Brevard County (1977) study is also difficult to ascribe specifically to WIC: the difference is in countywide rates before and after the start of WIC programs, and other changes may have taken place simultaneously with the institution of WIC. The reduction of 1.8 percent observed by Sharbaugh et al. (1977) in north central Florida was among MIC recipients before and after the introduction of WIC.

4. Summary

Despite many uncertainties of design and analysis in this group of studies, the most likely range for reduction in the rate of low birthweight associated with WIC is about 1 percent and possibly as high as 2 percent. Several of the estimates around 2 percent (e.g., Edozien et al. and Kotelchuck et al.) are problematic; but taken together with the Missouri studies (Schramm, 1983; Stockbauer and Blount, 1983), these are the best now available. It would be most helpful to have further data from Missouri for years other than 1980. While results generated from one State may not be applicable to other States, given that some program elements are almost certainly specific to that State since program eligibility and constitution of WIC supplemental food packages are relatively uniform nationally, the Missouri results may be assumed roughly applicable to other populations. There is internal evidence of under-control in the Missouri studies. Perinatal mortality among whites receiving WIC was worse than for whites not receiving WIC, even after statistical control for weight at conception, cigarette smoking, and maternal education (among blacks, perinatal mortal-

ity was considerably lower among WIC recipients than among controls). Thus, white controls may have been at lower initial risk than white WIC recipients (black controls may or may not have been at higher risk). It would be of great value to study, with available data, any additional social or medical indices beyond those used for control purposes in order to assess comparability of WIC recipients and controls, separately for the two racial groups. It would be very important to know whether any women were excluded from the WIC sampling frame before the linkage with their infants' birth certificates.

The best estimates of the effect of prenatal WIC benefits on birthweight are from 15 to 20 grams (probably low) up to 60 grams. Higher estimates are suspect for the reasons specified. Thus, the effects appear to be real, but their magnitude is uncertain. On the other hand, the only relevance of such increases in birthweight are whether they confer an improved chance of survival or lead to accelerated growth and development, both somatic and psychological. As indicated below, these central questions cannot now be answered.

C. DIFFERENCES IN PERINATAL OR INFANT MORTALITY ASSOCIATED WITH WIC BENEFITS DURING PREGNANCY

Results for perinatal and infant mortality differences are summarized in Table II-2. They are neither uniform nor easily interpreted. In several of the studies, observed differences cannot be credited to WIC. In the studies in Waterbury, Connecticut, by Carabello et al. (1978), much of the very large observed difference is quite likely a function of how deaths were assigned to the WIC and control groups. All deaths that could not be linked to prenatal WIC records were assumed to arise from the control group. There is, thus, almost certainly an undercount of deaths among WIC recipients and an overcount among controls. Likewise, the difference between current and past perinatal mortality rates by Schelzel and Britton (1978) is probably exaggerated because past adverse pregnancy outcome was a factor leading to recruitment into the WIC program. The reported rates of past loss of well over 10 percent are consistent in this interpretation. The results, therefore, are likely due in large part to regression to the mean. Uncertainties in the differences in neonatal death between WIC recipients and controls in the study of Kotelchuck et al. (1981; 1982) are discussed in Appendix II-A. There is very likely an undercount of deaths in the WIC group. The reported differences cannot be judged secondary to WIC benefits until outcome has been determined for the group of women excluded from their analysis who were "terminated" from the WIC program and who may well have been terminated because they gave birth prematurely, with infants who consequently died. Stockbauer and Blount (1983) studied all 1980 births in Missouri and Schramm (1983) all births to Medicaid recipients. Stockbauer and Blount found higher perinatal and neonatal death rates among WIC recipients than among controls, even after controlling for prepregnant weight, cigarette smoking, education, and race. Among whites, perinatal mortality rates were significantly higher among WIC recipients, but significantly lower among blacks. It would be helpful to know the social and health status of the WIC and control groups, over and above the

Table II-2

Reported Differences in Perinatal or Infant Mortality per 1,000 Associated With WIC Benefits During Pregnancy

Authors	Category	WIC	Control	Difference	n, subjects	n, controls
Carabello et al. (1978)	Perinatal	10.5	24.5	-14.0**	1,791	2,471
	Infant	8.4	22.7	-14.3**		
	Comment: Almost certain undercount of WIC deaths, since all deaths not linked to prenatal WIC records assumed to be among control group. Denominator for WIC death rate inflated: not all counted had delivered during period of study. Waterbury, Connecticut, 1975-77.					
Kotelchuck et al. (1981)	Neonatal	2.91	8.48	-5.57**	4,126	4,126
	Comment: Likely undercount of WIC deaths because terminated WIC cases excluded from study. Massachusetts, 1978.					
Kotelchuck et al. (1982)	Neonatal	-4.6	0	-4.6	1,309	1,309
	Comment: Subset of same study population as Kotelchuck et al. (1981). Differences across pregnancies.					
Schelzel & Britton (1978)	Duration WIC benefits (mo)	Current pregnancy	Past pregnancies	Diff.		
	<6	16.1	106.4	-90.3	64	-
	≥6	0	141.3	-141.3	55	-
	Comment: Current infant mortality compared to that from past births if past adverse outcome led to certification, results confounded by regression to the mean.					
Schramm (1983)		WIC	Control	Diff.		
	Neonatal	9.4	8.9	0.5	1,883	5,745
	Postneonatal	5.8	8.6	-2.8		
	Comment: All Medicaid births, Missouri, 1980.					
Stockbauer and Blount (1983)	Perinatal	20.7	20.2	0.5	6,657	71,931
	White	21.4	15.9	5.5*		
	Black	19.3	28.8	-9.5*		
	Infant	16.3	16.1	0.2		
	White	15.8	13.0	2.8		
	Black	17.2	21.8	-4.6		
	Comment: All births, Missouri, 1980, controlled for prepregnant weight, cigarette smoking, education, and race.					

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

issues that were controlled in analysis. The higher death rate among white WIC recipients was likely not an adverse effect of the program but probably a reflection that white WIC recipients were at higher initial risk than nonrecipients were and that analytic control for several characteristics was not enough to make the two populations equivalent in risk. Further information comparing black WIC recipients and controls would also help judge whether their lower perinatal mortality rate (19.3 vs. 28.8 per 1,000, $p < 0.05$) was more likely a function of lower prior risk or of the program.

Whether, by how much, and among whom WIC participation led to lowered perinatal mortality remain in question.

D. DIFFERENCES IN HEMATOLOGIC INDICES ASSOCIATED WITH WIC BENEFITS

The relationship of WIC benefits to hemoglobin or hematocrit concentration as well as to other hematologic indices was reported in 14 studies. These are summarized in Table II-3. However, only four of these studies, those of Bailey et al. (1983), Collins et al. (1981), Kennedy and Gershoff (1982), and Paige (1983), used controls. In all other studies, hematologic indices before treatment were compared to levels after treatment. Because low hematologic indices were criteria for certification in the WIC program, observed change in these pre-/postcomparisons is subject to a greater or lesser extent to regression to the mean, which cannot be distinguished from program effect.

One of the controlled studies was of infants under age 1 (Paige, 1983); none were of children over age 1. Paige found no difference in hemoglobin or hematocrit levels between infants who were enrolled in WIC and controls from health department clinics in two Maryland counties without WIC programs.

The other three controlled studies were among pregnant women. That of Bailey et al. (1983) had many internal inconsistencies (e.g., seeming discrepancies between tables and text). Collins et al. (1981) found no association between WIC benefits and hemoglobin or hematocrit levels among low-income pregnant women in health department clinics in six Alabama Appalachian counties. Kennedy and Gershoff (1982) found greater increases in hemoglobin and hematocrit levels for pregnant WIC recipients than for pregnant controls. However, it is unclear whether the subgroup of women for whom hematologic data were available was representative, and the statistical tests were not for differential change but for mean level at last clinic visit. Because the control group started at lower levels and the final level was not adjusted for initial level, the tests of statistical significance did not take into account this initial disparity. Also, internal evidence suggests that controls were at greater biological or social risk than cases were (see study description, Appendix II-A).

It is thus impossible, from this small set of studies, to draw any conclusions as to the effect of the WIC program on hematologic indices. This is clearly a major gap in knowledge of the WIC program's effective-

ess, one in which the technology of investigation is fairly clear but for which the administrative barriers to proper study are great.

Table II-3

Reported Changes in Hematologic Indices Associated With WIC Benefits

Authors	Results				n, subjects	n, controls
Bailey et al. (1983)	No difference in Hct, pyridoxyl phosphate, serum iron; WIC group: significantly higher transferrin saturation (37% vs. 23%, $p < 0.001$), lower serum folacin (14 vs. 26 ng/mL, $p < 0.01$), red blood cell folacin (353 vs. 602 ng/mL, $p < 0.001$).				43	58
	Comment: Pregnant women at 30th week of gestation: discrepancies between text and tables. Comparability of controls uncertain.					
CDC (1978)		% low Hct or Hgb				
	Initial age (mo)	Initial visit	Followup First	Followup Second		
	6-23	13.4	5.0	3.9	1,698	-
	24-47	29.1	13.7	11.1	1,091	-
	6-23	100.0	14.2	7.5*	226	-
	24-47	100.0	23.9	19.2	317	-
	Comment: Change between followup visits only minimally confounded by regression to the mean. Data from CDC nutrition surveillance States.					
Collins et al. (1981)		WIC	Control			
	Hgb (g%)	12.9	12.8		83	80
	Hct (%)	36.3	36.9		204	72
	Comment: Low-income pregnant women in health department clinics in six Alabama Appalachian counties.					
Deterding et al. (1983)		% Hgb <11 g/dL Initial visit	% Hgb <11 g/dL 6-month followup			
		13.3	4.0**		173	-
	Comment: Nebraska Indian children, 1- to 4-year-olds. Result subject to regression to the mean. No controls..					

(continued)

Table II-3 (continued)

Authors	Results	n, subjects	n, controls
Development Associates, Inc. (1979)	Mean Hct (see below)	-	-

Age(yr)	WIC Migrant Demonstration Project: Initial	Followup	n	Regular WIC project: Initial	Followup	n
Women	35.5	38.4	(43)	35.5	38.6	(129)
<1	32.2	34.2	(31)	31.0	33.3	(38)
1-5	34.1	34.3	(75)	33.8	34.4	(81)

Comment: Migrants in demonstration or regular WIC programs, Midwestern and Southwestern States. Results subject to regression to the mean.

Authors	Results	n, subjects	n, controls
Edozien et al. (1976a, 1976b; 1979)	Change from initial visit (see below)	Age (mo) <12; 12+	Age (mo) <12; 12+

Change from initial visit	Age of child (mo) 6-11, Time on program (mo) 6	12-47, 6	12-47, 11	n, subjects	n, controls
Hgb (g%)	0.38	0.34	0.42	(2,705; 7,608, 4,910)	(3,363; 14,959)
Hct (%)	0.61	0.79	0.78		
MHCC (g%)	0.51	0.24	0.45		
Transferrin (mg%)	-19.0	2.9*	-20.0	(2,040; 5,980, 4,012)	(2,316; 10,569)
saturation (%)	NS	-1.3	NS		

All p < 0.001 except as noted.

Comment: First National WIC Evaluation. Changes to first followup visit confounded by regression to the mean.

Authors	Results	Age (mo) 3-	6-	24-60	n, subjects	n, controls
Goldberg (1982)	% anemic	8.6	5.7	1.0	105	-

Comment: 18- to 68-month-olds, in Harlem Hospital WIC program, certified at least three times.

Authors	Results	WIC: Initial	Final	Diff.	Controls: Initial	Final	Diff.	n, subjects	n, controls
Kennedy et al. (1982), Kennedy and Gershoff (1982)	Hgb (g%)	12.4	12.6	0.2	11.9	11.7	-0.2	148	84
	Hct (%)	35.8	36.7	0.9	35.6	35.1	-0.5		

Comment: Subset of pregnant women with hematologic measurements. Significance tests not for differential change.

(continued)

Table II-3 (continued)

<table>
<tr><th>Authors</th><th>Results</th><th>n, subjects</th><th>n, controls</th></tr>
<tr><td>Langham et al. (1975)</td><td>No change after second visit, infants or children.

Comment: 0- to 4-year-olds, from 10 rural parishes in Louisiana. Graphic presentation of repeated cross-sectional data. Initial change confounded by regression to the mean.</td><td>1,465</td><td></td></tr>
<tr><td>Paige (1983)</td><td><table>
<tr><th></th><th colspan="2">WIC</th><th colspan="2">Controls</th></tr>
<tr><td>Hct (%)</td><td>34.2</td><td>34.5</td><td>35.5</td><td>35.4</td></tr>
<tr><td>Age (mo)</td><td>6.4</td><td>11.8</td><td>6.2</td><td>11.6</td></tr>
<tr><td></td><td>(141)</td><td>(134)</td><td>(18)</td><td>(192)</td></tr>
</table>
Comment: WIC infants from three Maryland counties, controls met same eligibility criteria, recruited from health department clinics in two Maryland counties without WIC programs.</td><td></td><td></td></tr>
<tr><td>Pelto (1982)</td><td><table>
<tr><th></th><th colspan="3">Hgb/dL</th><th></th></tr>
<tr><th></th><th>Initial</th><th>Recertification</th><th>n</th><th></th></tr>
<tr><td>Anchorage</td><td>10.7</td><td>11.6</td><td>219</td><td>(women, infants, and children)</td></tr>
<tr><td>Juneau</td><td>10.9</td><td>12.3</td><td>27</td><td>(children)</td></tr>
</table></td><td></td><td></td></tr>
<tr><td>Rye et al. (1978a)</td><td><table>
<tr><th colspan="4">Low Hgb or Hct</th></tr>
<tr><th colspan="2">1976-77[a]</th><th colspan="2">1977-78[b]</th></tr>
<tr><th>Initial</th><th>After intervention</th><th>Initial</th><th>After intervention</th></tr>
<tr><td>17.2</td><td>5.1</td><td>7.4</td><td>1.3</td></tr>
</table>
Comment: Infants and children in 14 county and tribal WIC programs in Arkansas. Results confounded by regression to the mean.</td><td>1976-77: "over 13,000"
1977-78: 17,934</td><td>-
-</td></tr>
<tr><td>Schelzel and Britton (1978)</td><td><table>
<tr><th colspan="2">Low Hgb or Hct (%)</th></tr>
<tr><th>Initial</th><th>After intervention</th></tr>
<tr><td>24.0</td><td>7.7</td></tr>
</table>
Comment: Children in two Pennsylvania WIC programs. Results confounded by regression to the mean.</td><td>233</td><td>-</td></tr>
</table>

[a] Assuming 13,000 screened.

[b] Assuming 17,934 screened.

(continued)

Table II-3 (continued)

Authors	Results	n, subjects	n, controls
Weiler et al. (1979)	1.0 g/dL Hgb increase at recertification	37	-
	Comment: Observed change subject to regression to the mean.		

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Of the various studies in which indices after treatment are compared to those before treatment was begun, some conclusions probably can be drawn from the linked results reported by the CDC (1978). While change from recruitment to first followup visit is strongly confounded by regression to the mean, changes after first followup visit are much less confounded. There was a regular trend downward in the proportion of children with low hematocrit or hemoglobin concentrations, even after the first followup visit.

Further work on the effect on hematologic indices of the WIC program in particular and of supplemental feeding programs in general is very much needed. Other strategies for contending with anemia should be evaluated. Approaches other than general feeding programs are possible, such as screening and treating with iron supplements persons with very low values of hemoglobin or hematocrit. No conclusions are now possible on the effect of the WIC program on hematologic indices. Because of their possible importance, any effects of the WIC program on iron nutrition (Lozoff, 1984) needs to be better documented and new study strategies tried.

In addition, the consequences of better iron stores need study. Do children with optional iron stores function better? This is still in question.

E. CHANGES IN INFANT AND CHILD GROWTH ASSOCIATED WITH WIC BENEFITS

Table II-4 summarizes the results of 12 studies that related child growth to WIC benefits. Of these 12, only that of Paige (1983) included controls who were followed comparably to WIC recipients. Paige studied WIC recipients from several counties and infants from health department clinics in other counties in Maryland who met WIC income and nutritional eligibility criteria. The growth of controls and WIC recipients was indistinguishable. All other studies followed groups of children over time and compared them either to their initial values or to children of the same age newly recruited into the program. In the large CDC (1978) study, with results from linked measurements from five States in the CDC Nutrition Surveillance System, change between initial visit and first followup was strongly sub-

Table II-4

Reported Changes in Infant and Child Growth Associated With WIC Benefits

Authors	Results	n, subjects	n, controls
Belshaw (1982)	Navajo infants (0 to 23 months); 18% overweight at onset of WIC program (1979); 14% 2 years later (1981). Comment: Sample sizes not specified.	9,444	-
Carabello et al. (1978)	0 to 1 year: WIC group significantly smaller at birth but indistinguishable at 6 months and 1 year Kindergarten age: no significant differences. Comment: Part of catchup 2° to regression to the mean.	61 102	65 91

CDC (1978)

Age (mo)	% length or height <10th percentile: Initial visit	Followup visit: First	Followup visit: Second		% weight/length <10th percentile: Initial visit	Followup visit: First	Followup visit: Second	
0- 5	13.9	17.3	17.9	(1,528)	10.2	6.6	5.7	(1,497)
6-23	21.1	18.0	15.8	(1,496)	7.8	6.6	5.5	(1,482)
24-47	16.6	15.2	18.1	(1,018)	6.8	6.0	5.0	(1,003)

Comment: Nutrition Surveillance, 5 States. Initial difference subject to regression to the mean; change between followup visits less affected.

Deterding et al. (1983)

Initial age (mo)	Mean change in percentile/month: Height/age	Weight/height	Weight/age
≥1	NA	NA	0.33**
≥24	0.77**	0.08	NA
n	(162)	(140)	(304)

Comment: Nebraska Indian children. No controls. Results subject to regression to the mean.

(continued)

Table II-4 (continued)

Authors	Results	n, subjects	n, controls

Development Associates, Inc. (1979)

% <10% length/age

	WIC Migrant Demonstration Project			Regular WIC project		
Initial Age (yr)	Initial visit	Followup		Initial visit	Followup	
<1	24.3	18.4	(74; 60)	15.4	15.4	(78)
1-5	18.9	22.6	(143;115)	17.8	25.0	(101;100)

Comment: Migrant children in WIC demonstration or regular WIC programs, Midwestern and Southwestern States. Results subject to regression to the mean.

Edozien et al. (1976a, 1976b; 1979)

Differences between children enrolled in WIC and new recruits

Age of child	6-11	12-47		n, subjects	n, controls
Time on program (mo)	6	6	11		
Weight (g)	123	240	113	(1,993,	(2,756,
Height (cm)	0.23	0.51	0.56	5,088,	10,947,
Head circ. (cm)	0.13	0.09	0.02	3,678)	10,947)

Comment: 19 WIC projects, 14 States.

Goldberg (1982)

% <10th percentile NCHS growth curve
Children 18 to 60 months at third recertification

	Certification #1	Certification #2	Certification #3	n, subjects	n, controls
Weight	7.6	4.7*	4.7*	105	-
Length	13.3	10.4	3.8*		

Comment: Chart review, Harlem Hospital WIC program; initial change subject to regression to the mean to the extent that impaired growth was criterion for WIC eligibility. Significance testing compared to initial rate.

(continued)

Table II-4 (continued)

<table>
<tr><th>Authors</th><th>Results</th><th>n, subjects</th><th>n, controls</th></tr>
<tr><td>Heimendinger
(1981)</td><td>Estimated difference, in Z scores, from predicted values, time since entry into WIC program (mo).
<table>
<tr><th></th><th>3</th><th>6</th><th>9</th><th>12</th><th>18</th></tr>
<tr><td>Length</td><td>.18**</td><td>.00</td><td>.01</td><td>-.06</td><td>-.29*</td></tr>
<tr><td>Log weight</td><td>.36***</td><td>.11</td><td>.10</td><td>.05</td><td>.20</td></tr>
<tr><td>Weight for length</td><td>.29***</td><td>.02</td><td>.06</td><td>.08</td><td>.09</td></tr>
</table>
<u>Comment</u>: Children at three WIC sites in Massachusetts. Overweight children omitted. Although "corrected" for regression to the mean, results consistent with effect of regression to the mean. Predicted values based on sex, age, and initial value, using NCHS standards.</td><td>905</td><td>NCHS standards</td></tr>
<tr><td>Hicks
et al.</td><td>No significant difference in growth, other than +% of visits; height for (1982) age low among older siblings.

<u>Comment</u>: Sibling pair study, (younger) subject with prenatal WIC, (older) control with WIC after first birthday. Shorter older siblings consistent with preselection of those at higher risk.</td><td>21</td><td>21</td></tr>
<tr><td>Langham
et al.
(1975)</td><td>
<table>
<tr><th>Age (yr)</th><th>Height</th><th>Weight/height</th></tr>
<tr><td><1</td><td>% <10th percentile, >90th percentile</td><td>% >90th percentile</td></tr>
<tr><td>1-4</td><td>% <10th percentile, >90th percentile</td><td>No change</td></tr>
</table>
<u>Comment</u>: Children in 10 rural parishes in Louisiana; graphic presentation of repeated cross-sectional data.</td><td>604
861</td><td>-
-</td></tr>
<tr><td>Paige
(1983)</td><td>
<table>
<tr><th></th><th>WIC</th><th></th><th>Control</th><th></th></tr>
<tr><td>Age (mo)</td><td>6.4</td><td>11.8</td><td>6.2</td><td>11.6</td></tr>
<tr><td>Weight (K)</td><td>7.8</td><td>9.8</td><td>7.9</td><td>9.7</td></tr>
<tr><td>Length (cm)</td><td>66.2</td><td>73.8</td><td>66.7</td><td>74.0</td></tr>
<tr><td>Weight/length</td><td>0.12</td><td>0.13</td><td>0.12</td><td>0.13</td></tr>
<tr><td>Head circ. (cm)</td><td>43.0</td><td>46.1</td><td>43.3</td><td>45.9</td></tr>
</table>
<u>Comment</u>: WIC infants from three Maryland counties; controls met same eligibility criteria and recruited from health department clinics in two Maryland counties without WIC programs.</td><td>148</td><td>213</td></tr>
</table>

(continued)

Table II-4 (continued)

Authors	Results					n, subjects	n, controls
Rye et al. (1978a)	Proportion abnormal (%)					1976-77: "over 13,000" 1977-78: 17,934	-
		1976-77[a]		1977-78[b]			
		Initial	After intervention	Initial	After intervention		
	Short stature	18.0	7.8	13.6	6.3		
	Underweight	7.7	2.0	5.8	1.0		
	Overweight	19.7	9.5	14.2	7.0		
	Comments: Infants and children in 14 county and 9 tribal WIC programs in Arkansas. Results confounded by regression to the mean.						
Schelzel and Britton (1978)	Proportion abnormal (%)					49 infants 233 children	-
		Infants		Children			
		Initial	After intervention	Initial	After intervention		
	Height, <5th percentile	16.3	10.2	14.2	7.3		
	Weight, <5th percentile	16.3	12.2	12.0	6.9		
	Weight, >95th percentile	4.1	4.1	4.7	5.2		
	Comments: Two Pennsylvania WIC programs. Results confounded by regression to the mean.						

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]Assuming 13,000 screened.

[b]Assuming 17,934 screened.

ject to regression to the mean. There was very little subsequent change (less subject to this confounding), unlike the results for hematologic change. In the Edozien study (1976a,b; 1979), results may reflect the possibility that later recruits were not comparable to earlier recruits; the data available cannot be used to judge this issue. The results reported by Heimendinger (1981), while stated to be corrected for regression to the mean, appear to be consistent with that effect: significantly greater length and weight than that predicted were found only up to 6 months after entry into the WIC program (predicted values were based on age, sex, and initial value, using National Center for Health Statistics [NCHS] standards). After 6 months of program benefits, growth of children was indistinguishable from that initially predicted. This brief initial significant difference from predicted values, therefore, is more consistent with regression to the mean than with sustained benefit.

Thus, as with hematology, evaluating WIC's relationship to child growth is plagued by uncertainty. Only one study included controls, and it appears nearly impossible to draw firm conclusions about the WIC program's effect on somatic development of infants and children. The program probably has not affected children's linear growth; but given current knowledge, this is not surprising and should not be counted against the program because, even among deprived children in the developing world, the observed effect of feeding programs in childhood on linear growth has been minimal (Beaton and Ghassemi, 1982).

Several important issues remain. There may well be improved child growth following prenatal or combined prenatal and postnatal benefits, and there also may be differential effects on other than linear growth. Results of this national evaluation strongly suggest that prenatal benefits may lead to increased head, but not linear, growth.

F. DIFFERENCES IN DIETARY INTAKE ASSOCIATED WITH WIC BENEFITS DURING PREGNANCY

There is relatively little information on the effects of WIC on dietary intake. A summary of quantitative dietary studies is presented in Table II-5. While 24-Hour Dietary Recalls were used in all the evaluations, the study designs and methods of presentation differed. Four of the studies were of pregnant women, two of postpartum women, and one of infants and children.

In three of the four studies of pregnant women, WIC had significant effects on protein intake. The increases ranged from 4.6 (Endres et al., 1976a, b; 1979) to 10.6 g/day (Endres et al., 1981). Only Endres et al. (1981) found a significant increase in energy intake among WIC participants. Iron intake was significantly increased in two of the three studies in which iron intake was reported, ranging from 1.0 mg/day to 3.3 mg/day.

One of the two studies of postpartum women was of lactating women (Argeanas and Harrill, 1979), the other was of nonlactating women (Edozien et al., 1976a, b; 1979).

From the data available, it is likely that WIC program participation had reasonable effects on the usual dietary intake of pregnant or postpartum women; the information for infants and children is too scanty for certainty.

G. CONCLUSIONS

1. Introduction

While the body of research aimed at judging the effects of participation in the WIC program on health and development is large, sound research from which strong inference can be drawn is limited, as is the scope of issues addressed. The conclusions that are possible reflect these limitations. This section addresses the security of our knowledge, some thoughts on future priorities, and how possibly to achieve those priorities.

Table II-5

Reported Differences in Energy, Protein, Iron, and Calcium Intakes Associated With WIC Benefits

Author	Results	n, subjects	n, controls
Argeanas and Harrill (1979)	Lactating Women: Mean daily dietary intake	11	5

	WIC		Controls		Difference	
	Weeks postpartum					
	0-6	8-15	0-6	8-15	0-6	8-15
Energy (kcal)	1,729	2,039	2,438	2,356	-709	-317
Protein (g)	87.1	101.1	118.0	99.6	-30.9	1.51
Iron (mg)	13.4	15.2	15.3	15.7	-1.9	-0.5
Calcium (mg)	980	1,003	1,801	1,382	-821	-379

Comment: Study and control groups probably not comparable: WIC participants presumably low income, controls reported to be middle income.

Author	Results	n, subjects	n, controls
Bailey et al. (1983)	Pregnant Women: Mean daily nutrient intake	41	37

	WIC	Controls	Difference
Energy (kcal)	2,390	2,496	-106
Protein (g)	90	105	-15
Iron (mg)	17	16	1.0

Comment: WIC participants at 30 weeks gestation from one WIC project vs. control women from public clinic in Florida. Discrepancies between text and tables (i.e., protein and energy intakes stated to be not statistically significant in text but indicated as statistically significant in table).

(continued)

Table II-5 (continued)

Author	Results	n, subjects	n, controls
Edozien et al. (1976a, 1976b; (1979)	Estimated increase in daily nutrient intake compared to initial intakes (mg, unless stated; significant values only)		

	Pregnancy	Postpartum
Energy (kcal)	-	-
Protein (g)	4.6*	-
Calcium	123***	-
Fe	1.0**	-
Initial	(2,754)	(179)
>3 m participation	(299)	(421)

Comment: Estimates for women after 3 months' participation in WIC.

	Children: Age of child (m)		
	6-11	12-47	
	Time on program (m)		
	6	6	11
Energy (kcal)	-	-	-
Protein (g)	-7***	3***	4***
Calcium	-127***	.85***	73***
Fe	5.1***	1.6***	1.5***
Initial	(912)	(3,584)	(3,584)
Followup	(506)	(1,292)	(1,008)

Comment: Children's differences adjusted for age, sex, ethnic group, "income poverty ratio," project location.

(continued)

Table II-5 (continued)

Author	Results	n, subjects	n, controls
Endres et al. (1981)	Pregnant Women: Mean daily nutrient intake	115	651

	WIC	Controls	Difference
Energy (kcal)	1,924	1,678	+246*
Protein (g)	79.8	69.2	+10.6*
Iron (mg)	14.8	11.5	+3.3*
Calcium (mg)	972	792	+180*

Comment: Women receiving WIC for 6 months vs. women requesting WIC certification, Illinois. Data were only reported as percent RDA from 1974 RDA (except for energy). Mean values, therefore, calculated from 1974 RDAs for 19 years to 22 years pregnant women.

Author	Results	n, subjects	n, controls
Metcoff et al. (1982)	Pregnant Women: Mean daily nutrient intake	145	125

	WIC	Controls	Difference
Energy (kcal)	1,965	1,883	+82
Protein (g)	79.3	71.8	+7.5*

Comment: Randomized trial. Diet recall at 36 w gestation.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

2. Current Knowledge of the Effects of the WIC Program on Health and Growth and Development

WIC Participation During Pregnancy

Hematologic Indices. Information is fragmentary, with few sound studies available. It is unclear whether WIC participation increases iron stores and the circulating red cell mass. This is an important issue. There is no consensus that all pregnant women should receive 30 to 60 mg/day of elemental iron as suggested by the Committee on Recommended Daily Allowances of the Food and Nutrition Board of The National Academy of Sciences; many knowledgeable experts recommend meeting the extra iron needs of pregnancy from dietary sources.

Weight Gain, Change in Energy Stores, and Plasma Volume. The weight increase of pregnancy has three (predominant) components: the products of conception, increased energy stores, and increased water retention (whether maternal protein stores increase is a matter of dispute). The increase in plasma volume appears to be the physiologically most important part of the increase in body water. All of these components of weight gain, in part, reflect the nutrition of the pregnant woman. How, and even whether, participation in the WIC program relates to these very important changes in pregnancy is not securely known, nor is it known whether they in turn have improved the health and development of the fetus and young child.

Duration of Gestation and Birthweight. There are more studies of the relationship of prenatal WIC benefits to infant birthweight than to any other outcome. This abundance reflects the issue's importance but also the relative ease of study: indices of outcome are clear and consistent across studies, results are available after relatively short involvement with the program, and there is a long tradition of uniform gathering of vital statistics relating to perinatal outcome. Thus, many studies have been done, but quality is uneven.

Best estimates are that participation in the WIC program increases mean birthweight, probably 20 to 60 grams, with greatest effects among those at highest risk of nutritional causes of low birthweight (women with low weight at conception, blacks, smokers, etc.). Rates of birthweight under 2,500 grams appear to be lowered by about 1 percent, and possibly as much as 2 percent, from base rates of around 6 percent of white births and 11 or 12 percent of black births. There is reasonably consistent evidence that much of this difference is mediated by increased duration of gestation and not just accelerated fetal growth. (Towards term, about a 25-gram increase in birthweight is associated with 1 day of gestation.) These levels of benefit are consistent with past experience with nutritional supplementation in pregnancy. Higher estimates generally arose from studies with suspect design and analysis.

Further studies of WIC's effect on birthweight are needed to define which subgroups of women may be most responsive to nutritional supplementation, and to whom attention should therefore be directed, on the mechanisms

for birthweight change (whether from increased duration of gestation or from accelerated fetal growth, and the physiologic bases of either or both mechanisms). Such studies are also needed to determine whether other indices of fetal growth, specifically head circumference, are differentially affected. Most of all, the implications of birthweight change on survival and later growth and behavioral and cognitive development need to be specified and quantified.

Fetal and Infant Survival. Probably the most important benefit of WIC participation during pregnancy is on fetal and infant survival, whether mediated by improved health care, or nutrition, or both. Yet, the available data on this issue are so scanty that any conclusion on program effect from past research is unwarranted.

WIC Participation During Infancy and Childhood

Hematologic Indices. The number of studies of these important issues is very small, of mixed quality, and contradictory in outcome. Anecdotal evidence strongly indicates that the WIC program has led to a decreased incidence of anemia in late infancy and early childhood (Lozoff, 1984). In addition, the data of the CDC nutrition surveillance studies (1978), even if cautiously interpreted, still suggest that the WIC program has led to decreased incidence of anemia. However, this documentation is scanty and this issue warrants further serious and close attention, even if the administrative and methodologic barriers to study are great.

Obesity. Obesity is probably the most common nutritional problem of American children and is more common among those of low social status. Despite the effects of obesity on later physical and mental health, there is essentially no secure evidence on whether the WIC program has been successful in treating or preventing childhood obesity.

Precursors of Adult Cardiovascular Disease. While obesity is likely the most common nutritional childhood disorder, probably the most serious issue in child nutrition is the relationship of childhood diet and lifestyle with later chronic cardiovascular disease. The WIC program probably contributes to the goal of lowering later cardiovascular risk, given the formulation of the WIC food package. However, no studies were found that test this issue, one way or the other.

Psychological and Behavioral Development. The relationship of nutritional status and, more narrowly, of nutritional supplementation to cognition and behavior is uncertain and controversial (Rush, 1984). On the other hand, several isolated reports suggest some benefit from WIC. These issues, while difficult to study well, need to be explored further.

Linear Skeletal and Skull Growth. It has long been assumed that food supplementation in childhood, such as that given in the WIC program, should above all be able to influence linear growth. This assumption is

questionable. The aggregate experience of feeding programs among poor children in the developing world is that they have little demonstrable effect on linear growth, except among the most destitute children (Beaton and Ghassemi, 1982). Thus, it may be very unlikely that such programs will have other than minimal effect among less severely deprived children. In fact, no study shows strong evidence of an effect of the WIC program during childhood on linear growth. (This does not exclude the possibility that prenatal supplementation may affect later linear growth or that different indices of growth may be affected differentially.)

III. HISTORICAL STUDY OF PREGNANCY OUTCOMES

A. INTRODUCTION

1. Justification

Three of the four component studies comprising The National WIC Evaluation are contemporary studies of current recipients of WIC benefits. The fourth is an historical study covering the period 1972 through 1980. There were several compelling reasons for attempting to discover the effectiveness of the program over its entire history. One reason is that, as the program has grown over time, it can no longer be assumed that its effect is limited to those formally enrolled; the goals and ideology of the program may have influenced general nutritional care in pregnancy and early childhood. Thus, estimates of differences of outcome between current WIC recipients and a contemporary comparison group might well be underestimates of program effect. Second, the WIC program now covers more and more of the eligible population, leaving relatively fewer and fewer unserved women and children of comparable risk. Thus, members of any group compared with WIC beneficiaries but who have not been involved in the program are likely to be at lower risk than those recruited into the program. Comparisons between WIC recipients and those not served would also tend to underestimate program effects. In addition, while some outcomes can be studied with relatively few subjects, the estimation of fetal and infant death, which is rare, requires massive numbers of births. Finally, this is a national evaluation, and the effects of the program should be estimated for as much of the nation as possible, extending forward from before the program's origin over as much of the first decade of its existence as possible. All past evaluations of the WIC program, except for the study of Edozien et al. (1976a) and the Center for Disease Control, Nutrition Section (1978), have been limited to small areas (at most, to all recipients in one State) for, at most, a few calendar years. As important as such studies might be, it is considered even more important to assess the program's effectiveness across a wider range of time and area.

2. Aims and Logic

This historical study therefore seeks to relate WIC participation during pregnancy to perinatal outcomes measured by birthweight, duration of gestation, and fetal and infant death in as many States as possible and over the entire early history of the program through 1980. No readily available extant data would allow the program's effects among infants and preschool age children over the past decade to be assessed.* On the other hand, there are well-collected systematic vital statistics records on births and fetal and infant deaths. The most straightforward and desired

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*This is not impossible since there may be centralized school records with data on growth and development, but such an approach was not feasible within the scope of this evaluation.

approach to using these data would link the records of individual mothers who received prenatal WIC benefits to the birth certificate of their child and/or the infant or fetal death certificate. Unfortunately, records of individual WIC participation are not available except for the past few years.

An alternative ecological approach has been used in this study in which the proportion of eligible women served by WIC in a county is linked to the perinatal outcome rates for the same county, by year, determined from birth and linked death certificates. Parallel data were available for the Commodity Supplemental Food Program (CSFP) during the years of this evaluation. The CSFP is a USDA program similar to WIC that provides nutritious foods to supplement the diets of low-income, pregnant, postpartum, or breastfeeding women and of infants and children under 6 years of age. Although a much smaller number of women were served by CSFP than by WIC, these data can only have strengthened this analysis and CSFP service has been treated (nearly) identically to that of WIC.

The aims and logic of the study are simple. The principal premise is that, as more eligible pregnant women are served by the WIC program, indices of health care should improve, the duration of gestation and birthweight should increase, and perinatal mortality should fall. Further, the effects should be greater on those indices reflecting maternal physiologic status during pregnancy (duration of gestation, birthweight, and fetal mortality) than on infant mortality, which more reflects the quality of health services from the onset of labor onwards.

3. Design Specifications

This Historical Study of Pregnancy Outcomes covered the 9-year period from 1972 to 1980. Data from 1,392 counties in 19 States and the District of Columbia, for a total of 11 million births, were available for analysis although the number of States used in specific analyses varied with the availability of data. Because the central analytic method used required complete data for the entire time series, States were excluded from initial analyses if data for the entire period were not available. States were also excluded if the data received from them was not consistent with figures from the National Center for Health Statistics (NCHS). The requirement of complete time series data resulted in elimination of five States from the main body of analyses. Given the importance of having maximal numbers of counties available in the analysis relating the WIC program to reductions in fetal death, the technical problem of including all States, with and without missing years of data, has been solved to produce a combined estimate of program effect.

From 14 states and the District of Columbia, 889 counties were included in analyses of the effect of the program on birthweight. Five hundred and eighty-two counties from seven States and the District of Columbia were available for the analyses of infant mortality. The former was the largest, and the latter the smallest number of counties available in these analyses. Outcome was also assessed separately, again within

county, by year among four subgroups of women defined by race (black or white) and years of schooling (<12 or 12+ years). Counties that had fewer than 50 births within the specific race/education subgroup under analyses were excluded from the subgroup analysis in question. The largest set of counties was 730 for the more educated whites in the analysis on birthweight. The smallest set of counties was 83 for less educated blacks in the estimates of the effect of the WIC program on infant mortality.

In initial analyses, WIC service within a county was defined in two different ways. The first was whether the program existed in a given county in a given year; a dichotomous variable called "presence." The second was an estimate of the WIC "penetration" index defined as the proportion of pregnant women newly certified for WIC program participation in a given county and year among the total number of pregnant women in the same county and year who were eligible for the WIC program. It was obvious early on that all estimates of program effect using the penetration index were considerably more precise and hence, more credible than those using presence. In this final report, all results refer to the analyses using penetration of the WIC program as the principal independent variable. Some of the early analyses using WIC presence are presented in Volume IV, Appendix III-A.

4. <u>Analytic Issues</u>

To relate WIC service to perinatal outcomes is difficult for several reasons. First, there have been remarkable improvements in perinatal, particularly neonatal, health and survival during the decade under study; second, many other factors have influenced perinatal health in addition to the WIC program; and third, the WIC program is selectively directed to areas of greatest need, or, in other words, with worst perinatal outcome. The analytic techniques of this study contend with these problems by adjusting for differences associated with time and for variation across counties. Thus, estimates of WIC's effect are over and above the dramatic changes that took place over the period of study and take into account variability between counties. Adjustment for time is, in part, overadjustment because some of the secular trends in outcome are due to an enlarging WIC program. The approach is thus conservative: estimates of effect are probably systematically low.

The effect of adjustment for variability between counties may not be immediately obvious. The analysis assumes three sources of variability in addition to chance or random variability: change with time, change due to the level of WIC penetration, and differences across counties due to all other sources of variability, the last contributed by the totality of other factors that differentiate one county and its population from another (such as social status, or health care, or ethnicity). In other words, the analysis presumes that each county has its own normal, basal, expected rate of outcome that reflects the characteristics of that county and its population. The estimated effect of the WIC program is over and above both the basal, expected rate and the general trend with time.

With further algebraic manipulation, it is possible to estimate not only the average effects of the WIC program applied to all births in either the county or among all births within one of the four subgroups defined by maternal race and education, but also the average benefit from service to each WIC program recipient. This is a legitimate estimate of the effect per recipient served, whether or not the effect was shared with others not directly served by the program.

B. DATA SOURCES, DATA ACQUISITION, AND FILE CONSTRUCTION

1. Overview

Data for the study were obtained from:

- Fetal and infant death records (the latter linked with the appropriate birth record), provided by the individual States included in the study.

- Birth certificates, provided by NCHS for some States and years based on a 50-percent random sample of births (Volume IV, see Appendix III-B).

- WIC participation rates, by WIC agency, gathered from the study States.

- CSFP service rates, provided by the Food and Nutrition Service (FNS).

- 1970 and 1980 Censuses.

This section describes:

- The process by which States were selected for the study and reasons for exclusion.

- The process of obtaining WIC program data, vital statistics data (birth records and fetal and infant death records), Census and Area Resource File data, and CSFP data.

- The preparation of the files for analysis.

The WIC program data were collected via a form completed by each selected State WIC office. The vital statistics data were acquired on computer tape from existing automated files in each participating State. The Census and Area Resources File data were obtained from 1970 and 1980 census tapes and 1978 and 1982 Bureau of Health Professions tapes, and the CSFP data were obtained from FNS.

2. Selection of Study States

States were initially included in the study if the number of women served by each WIC program and the counties covered by the program could be

provided, and if the State vital statistics data were in computer-readable form and a matched birth/infant death file in linkable files could be provided. A series of telephone conversations held with each State WIC Director determined the kinds of information that existed with respect to geographical coverage, number of participants served, and agency operations over the life of the agency. On the basis of these conversations, coupled with the then most current information about the existence and suitability of requisite vital statistics data, 34 States and the District of Columbia were selected for study. (For the purpose of this report, the District of Columbia shall be considered a State.) Table III-1 lists all States, notes the suitability of the WIC and vital statistics data, and gives reasons for exclusion of a State from the study.

The second phase of State selection occurred during the data collection step. Because of one or more of the following, 14 additional States were excluded:

- Inability to provide data for all years of the WIC program or WIC data otherwise inadequate (8 States).

- Extremely high cost of vital statistics data (2 States).

- Vital statistics data inadequate (2 States).

- Vital statistics data never received (2 States).

The final total of acceptable States was 21 (including the District of Columbia), representing 1,434 counties. Reasons for exclusion at the data collection stage are also noted in Table III-1.

3. Acquisition and Treatment of WIC Program Data

Data Collection

WIC program data on the number of pregnant women served by WIC over time were collected from State offices using a standardized format (copy included as Appendix III-C in Volume IV). Data of interest included are:

- Name of the State.
- Name of the local WIC program.
- Year the program started.
- Year it closed (if applicable).
- Counties the agency served with the years indicated that each individual county was served.
- Number of participants served by type (pregnant women, postpartum women, breastfeeding women, infants, and children) in March, June, September, and December for the years 1973-1981.

Table III-1

Summary of State Data Availability

State	Status of vital statistics data	Status of WIC data	Inclusion in Historical Study
Alabama	Computerized B,D,FD since 1976. B-D link is hard copy only.	Number served only available since 1978, lists of agencies and service area available since 1974.	No - No computer linkage for BD.
Alaska	*Computerized B,D. Computerized linkage since 1953.	No counties	No
Arkansas	No computerized files.	Data available since 1977.	No - No linkable B-D file.
Arizona	*Computerized B,D,FD since 1970. Linked by DB. Composite file for 1979 available.	Program data available since 1974.	Yes
California	*Computerized B,D,FD since 1960. Linked since 1960. No SES (ed, leg status available).	Program data available since 1974.	No - Absence of SES data on birth record.
Colorado	*Computerized B,D since 1959; fetal death since 1975. Linked by DB since 1975. Composite since 1975.	Number served available since 1978, lists of agencies and service area available since 1977.	Yes
Connecticut	*Computerized B,D,FD since 1957. Deaths within 2 yrs. linked. Composite since 1978. Linked type unknown.	Number served available since 1978, lists of agencies and service area available since 1974.	No - WIC data not available for all years.
Delaware	*Computerized B,D since 1974. FD hard copy. DB link since 1974. No SES data on FD.	Program data available since 1977.	Initially, yes, but excluded because vital statistics data too expensive.
District of Columbia	*Computerized B,D since 1967. FD since 1979. Linkage available and composite file since 1965.	Didn't have WIC until after 1980.	Yes
Florida	*Computerized B,D,FD since 1970. Linked by DB.	Program data available since 1975.	Initially yes, but excluded because vital statistics data never received.
Georgia	*Computerized B,D since early 1960's. FD since 1972. No SES in FD before 1980. Linked-type unknown.	Program data available since 1974. (Number served may not be available that far back).	Yes
Hawaii	*Computerized B,D,FD since 1960. Linked by BD.	Number served available since 1977. Lists of agencies and service area available since 1974.	No - WIC data not available for all years.
Idaho	*Computerized B,D,FD since 1970. Infant deaths linked. Type link.	Program data availabe since 1974.	Yes
Illinois	*Computerized file B,D,FD since 1961. Linked by DB.	Program data available since November 1974.	Yes
Indiana	Computerized B,D,FD file. Only hard copy linkage.	Number served available since 1976, lists of agencies and service area since 1975.	No - No computer linkage for BD.
Iowa	*Computerized B,D,FD since 1960's. Linked by BD.	Program data available since 1974.	Yes

(continued)

Table III-1 (continued)

State	Status of vital statistics data	Status of WIC data	Inclusion in Historical Study
Kansas	*Computerized B,D,FD since 1972. Linked by DB. No SES on FD.	Program data available since 1974.	Yes
Kentucky	*Computerized B,D,FD since early 1970's. Linked by BD.	Program data available since 1974.	Yes
Louisiana	*Computerized B,D,FD since 1960's. Linked-type unknown. No SES on FD.	Program data available since 1974.	Yes
Maine	*Computerized B,D,FD since 1960's. Linked-type unknown. Composite 1974-1980.	Program data available since 1974.	Yes
Maryland	Computerized B,D since 1973, FD since 1976. No SES on FD. No linkage.	Program data available since 1974.	No - No computer linkage of BD.
Massachusetts	Computerized B,D,FD since 1969. Link neonatal deaths by name. Composite file of neonatal from 1975.	Program data definitely available since 1978, maybe since 1974.	No-Only neonatal deaths linkable.
Michigan	*Computerized B,D since 1970. Linked - linkage unknown. Composite available from 1970.	Program data available since 1973.	Yes
Minnesota	*Computerized B,D,FD since 1960's. Linked by DB. Composite 1970-77.	Program data available since 1974.	Initially, yes, but WIC data subsequently not retrievable.
Mississippi	*Computerized B,D since early 70's. No FD. Linked since 1976 by BD.	Program data available since 1974.	Yes
Missouri	*Computerized B,D,FD since 1972, linked by BD and DB.	Program data available since 1974.	Yes
Montana	Computerized B,D since 1954. No FD file. No computer linkage of B-D.	Number served available since 1979, lists of agencies and service area available since 1978.	No - No computer linkage of B-D.
Nebraska	Computerized B,D,FD since 1976. Death indicator only.	Program data available since 1976 when the program started.	No - Date of death not known.
Nevada	Computerized B,D,FD since 1968. Hard copy linkage since 1978.	Program data available since 1974.	No - No computer linkage.
New Hampshire	Computerized B,D. No FD. No computer linkage.	Number served available since 1977, lists of agencies and service area available since 1974/1975.	No - No computer linkage.
New Jersey	Computerized file B,D,FD since 1960's. Hard copy linkage since '80.	Program data available since 1973.	No - No computer linkage.

(continued)

Table III-1 (continued)

State	Status of vital statistics data	Status of WIC data	Inclusion in Historical Study
New Mexico	Computerized B,D since 1960's, FD 1980. Hard copy. Date of death on B and indication on D and record in B. FD SES missing.	Program data available since 1974.	No - No computer linkage.
New York	*Computerized and composite file available 1950-Up-state, 1971-NYC	Program data available since 1974.	Yes
North Carolina	*Computerized and linked file available at TUCC for last 15 yrs.	Program data available since 1974.	Yes
North Dakota	No computerized files.	Program data available since 1975.	No - No computer linkage.
Ohio	Computer files since 1963. No linkage available. Have linked by name and date of birth for 3 years. 85% linkage.	Number served available since 1979, lists of agencies and service area available since 1974.	No - No computer linkage.
Oklahoma	*Computerized B,D,FD since 1975. Linked by DB.	Number served available since 1981, lists of agencies and service area available since 1976.	No - Limited WIC data available.
Oregon	*Computerized B,D,FD since 1960. Linked and composite file. Type linkage unknown.	Program data available since 1974.	Initially yes, but excluded because vital statistics data too expensive.
Pennsylvania	*Computerized B,D,FD since 60's. Linkable since '72. B has D match indicator. Composite 1974- No SES on FD.	Program data available since 1974.	Yes
Rhode Island	*Computerized B,D since 1968; FD since 1974. Linked since 1976 by BD.	Program data available since 1974.	Yes
South Carolina	*Computerized B,D,FD since 1970. Linked by DB. Composite 1976-1979.	Program data available since December 1974.	Initially, yes, but data never received.
South Dakota	*Computer B,D since 1960. Linked tape to 1972.	Program data available since 1976	Yes
Tennessee	Computerized file since 1980. Hard copy on B cert.	Number served available since 1977, list of agencies and service area available since 1974.	No - No computer linkage.
Texas	Computerized B,D since 1964. FD since 1970.	Program data available since 1974.	No - No computer linkage.
Utah	*Computerized B, 1970; D, 1956. Linked file composite since 1970. Type linkage unknown.	Program data availabla since 1976.	Yes
Vermont	*Computerized file B,D,FD since 1955. Linked file available. Composite since 1974. Separate infant death fila available.	Number served available since 1978, list of agencies and service area since 1973.	No - Limited WIC data available.
Virginia	Computerized since 1960 B,D,FD. Since 1977. No composite link until 1980.	Number served available since 1977, list of agencies and service area available since 1975.	No - No computer linkage of BD.

(continued)

Table III-1 (continued)

State	Status of vital statistics data	Status of WIC data	Inclusion in Historical Study
Washington	*Computerized B,D,FD since 1968. Linked by hard copy but merged file exist from 1968.	Program data available since 1974.	Yes
West Virginia	*Computerized B,D since 1945. FD since 1967. Linkage BD and DB. Composite 1974-1980.	Number served available since 1979, list of agencies and service area available since 1975/1976.	No - Limited WIC data available.
Wisconsin	*Computerized B,D,FD since 1965. Linkage available and composite. Type and dates link.	Number served available since 1978, list of agencies and service area available since 1974.	No - Limited WIC data available.
Wyoming	*Computerized B,D,FD since 1978. Linkable by B,D or DB since 1978.	Program data available since 1980 when the program began.	No - Series of years too short.

*Indicates availability of computerized, linked birth and death file. The symbols used in the column headed "Status of vital statistics data" are:

B = birth
D = death
FD = fetal death
DB = date of birth

In all but four States, the State WIC Agency staff provided the data themselves. In the four States (Arizona, Washington, Kentucky, and New York), site visits were made to each to obtain the data because staff time was not available for gathering the information.

Editing Procedures

When the data sheets from a State were received at RTI, they were logged in and edited and followup telephone calls were made to clarify ambiguous or missing information.* Edit steps included:

- Assigning an ID number.
- Checking the date the agency opened (and closed, if applicable) to see that this information agreed with the years that one or more of the counties were reportedly served.
- Checking for irregularities in the numbers of participants and in the periods for which agencies were to have been operating.
- Checking the reported total participation against the sum of the numbers reported by type of participants. At this stage, the data collection forms were keyed and a computer-readable file created.

WIC Program Coverage

In only two instances were the States able to provide breakdowns of the women participating in the program for a given period by whether they were pregnant, postpartum, or breastfeeding.† In one case in which the State (Kansas) was able to provide the breakdowns, only breakdowns for December 1981 were available. In the other (Maine), the details of program participation for women were available for 1981 for all months. In no case are these breakdowns available for earlier years.

In general, data for a given State cover the agencies' program histories, as shown in Table III-2, which provides a summary of the number of counties served by WIC by State by year as determined from the counties

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*Only five such calls were necessary. These involved cases either of large differences in reported agency participation from one reporting period to the next or of instances requiring clarification of agency names and service areas.

†States are required only to report the aggregate figures to FNS and have no mandate to maintain this level of detail by agency. It had been determined early in that data collection that the only way to obtain these breakdowns was to contact each local agency, and even then, short of individual record retrieval, it would not be feasible or cost-effective.

Table III-2

Number and Percentage of Counties Served by WIC by State by Year

State	Number of counties	1973	1974	1975	1976	1977	1978	1979	1980	1981
Arizona	14	0	12	14	14	14	14	14	14	14
%		.00	.86	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Colorado	63	0	7	7	10	25	34	38	41	41
%		.00	.11	.11	.16	.40	.54	.60	.65	.65
Connecticut	8	2	5	7	7	8	8	8	8	8
%		.25	.63	.88	.88	1.00	1.00	1.00	1.00	1.00
District of Columbia	1	0	0	0	0	0	0	0	0	1
%		.00	.00	.00	.00	.00	.00	.00	.00	1.00
Delaware	3	0	3	3	3	3	3	3	3	3
%		.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Florida	67	0	6	14	16	36	40	64	67	67
%		.00	.09	.21	.24	.54	.60	.96	1.00	1.00
Georgia[a]	159	2	27	30	87	157	156	157	157	157
%		.01	.17	.19	.55	.99	.98	.99	.99	.99
Idaho	44	0	1	10	23	35	36	38	41	42
%		.00	.02	.23	.52	.80	.82	.86	.93	.93
Illinois	102	0	12	19	25	25	31	54	62	63
%		.00	.12	.19	.25	.25	.30	.53	.61	.62
Iowa[b]	99	0	1	1	41	85	89	96	97	98
%		.00	.01	.01	.41	.86	.90	.97	.98	.99
Kansas	105	0	10	10	14	21	21	24	30	34
%		.00	.10	.10	.13	.20	.20	.23	.29	.32
Kentucky[c]	120	0	21	26	42	88	114	116	117	119
%		.00	.18	.22	.35	.73	.95	.97	.98	.99
Louisiana	64	0	10	29	38	39	57	62	63	63
%		.00	.16	.45	.59	.61	.89	.97	.98	.98
Maine	16	0	4	4	6	14	16	16	16	16
%		.00	.25	.25	.38	.88	1.00	1.00	1.00	1.00

(continued)

Table III-2 (continued)

State	Number of counties	1973	1974	1975	1976	1977	1978	1979	1980	1981
Michigan[b]	83	0	13	18	41	48	55	74	78	79
%		.00	.16	.22	.49	.58	.66	.89	.94	.95
Mississippi[b]	82	0	7	10	12	27	51	56	70	78
%		.00	.09	.12	.15	.33	.62	.68	.85	.95
Missouri[d]	114	0	2	12	58	65	74	86	97	105
%		.00	.02	.11	.51	.57	.65	.75	.85	.92
New York[c]	62	0	19	21	20	21	31	35	46	46
%		.00	.31	.34	.32	.34	.50	.56	.74	.74
North Carolina[c]	100	0	7	23	27	56	79	88	90	94
%		.00	.07	.23	.27	.56	.79	.88	.90	.94
Oregon	36	0	6	18	20	22	22	25	30	30
%		.00	.17	.50	.56	.61	.61	.69	.83	.83
Pennsylvania	67	0	14	21	26	35	48	51	66	67
%		.00	.21	.31	.39	.52	.72	.76	.99	1.00
Rhode Island	5	0	1	5	5	5	5	5	5	5
%		.00	.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00
South Dakota[e]	66	0	2	2	6	8	16	19	53	59
%		.00	.03	.05	.09	.12	.24	.29	.80	.88
Utah	29	0	0	0	12	16	25	25	26	27
%		.00	.00	.00	.41	.55	.86	.86	.90	.93
Washington	39	0	15	33	32	33	34	34	34	37
%		.00	.38	.85	.82	.85	.87	.87	.87	.95
Total	1,534	.4	205	338	585	886	1,059	1,188	1,311	1,352
%		.00	.13	.22	.39	.58	.69	.77	.85	.89

[a]County breakdowns only available 1979-1981.

[b]Data not available for first year of operation.

[c]Statistics not available for part of 1976 due to change in the Federal fiscal year from July to October.

[d]1978 data not available for county breakdowns.

[e]County breakdowns only available 1978-1981.

reported as served by each agency within a State. The percentage of counties served in a State is also shown to provide a picture of program coverage. Exceptions to coverage are also provided in Table III-2.

4. Acquisition of Vital Statistics Data

Data Collection

To acquire the vital statistics data, each of the States selected for study was first contacted by phone to verify that the data were available for the study years and that RTI would be allowed to obtain a copy. The data requested included fetal death and matched birth/infant death files; if a matched file was not available, linkable birth and infant death files were sought.*

Each State subsequently was sent a letter specifically requesting the needed files and asking for a firm price. In addition, an overview of the study and confidentiality procedures were sent to each State.

Each responding State was sent a purchase order itemizing the files needed. The prices for the files ranged from no charge to $4,200, resulting in a cost per county per year as high as $8.54. Two States (Idaho and Kentucky) performed their own linkage processing to provide the required linked data. Three States (Connecticut, Florida, and South Carolina) were dropped from the study because of nonresponse or unavailable data, and Delaware and Oregon were excluded because of the high price of the data files (refer again to Table III-1). Thus, data collection ended with 21 States providing vital statistics data at a cost of $30,704.

Processing

The preliminary processing of the vital statistics files began with steps to ensure consistency across States. Upon receipt of a State's data files (two or three files per year for up to 10 years), backup copies were made and the file format checked against the provided documentation. If any inconsistencies were discovered, clarification was requested and received from the State.†

Even though each State maintains basically the same data from the birth, death, and fetal death certificates, each has its own way of coding and recording the data variables, and in some cases a State's format may change across years. Therefore, the data processing system design not only accounted for the data format inconsistencies but also allowed for efficient processing. Specifically, since the vital statistics records for each county had to be aggregated for subsequent analysis, the data proces-

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*Total birth files were not necessary from each State. Rather, the NCHS Natality Data files for each State were used.

†Two States (Washington and Georgia) had to redeliver files due to inconsistencies and/or unreadability of tapes.

sing design allowed for the aggregate programs to be written by file type only, thereby avoiding a recheck of the program mathematics for each individual State and year. Figure III-1 presents the overall flow diagram of the processing system components.

Not all variables carried on the State files were required for analysis, although analysis cross-classification variables needed to be consistent across all file types (birth, infant death, and fetal death). Therefore, the overall system design included a step for extracting and recoding of State and NCHS variables into a format common to all file types using specialized software developed at the extraction step. The extraction programs were customized, not only to extract the variables from the proper locations, but also to recode and compute variables based on each State's coding and recording conventions. All conversions were performed in the extract program, so the output file format was consistent for the aggregate program.

Completeness

Many of the States did not have data files for all of the study years. In some cases, the States did not have fetal death files available (e.g., Michigan), and in other instances files were missing for certain years. In September 1982, none of the States had 1981 matched birth/infant death files available because all 1982 infant deaths had not yet occurred. In addition, NCHS did not have the 1981 Natality file ready; in fact, the 1980 file was only released in March 1983. Table III-3 provides a summary of the vital statistics data files available.

For States not fully cooperating in the NCHS reporting system, a 50-percent sample of the birth certificates is coded. Therefore, the aggregate program had to multiply each cell count by two to account statistically for each birth. Table III-4 shows the NCHS birth file status by year for each State.

In addition to incomplete data and/or files, data variables were missing. Table III-5 summarizes those variables missing on the NCHS files for the study States.*

In preparation for the preliminary analysis tasks, four States were processed through the extraction, aggregation, FIPS coding, codebook gene-

*NCHS does not carry these data for two reasons: (1) the data are not available from the State, or (2) the State inferred the data. For example, Washington State law does not allow the educational status of the mother to be on any birth certificate records; the same applies for the legitimacy (marital status) variable from Michigan. In the case of New York City and Georgia, State law does not allow the legitimacy variable to be recorded; however, locally the data are inferred from other variables. In this case, the NCHS birth files do not maintain the inferred data, but the State-supplied files provide a marital status indicator.

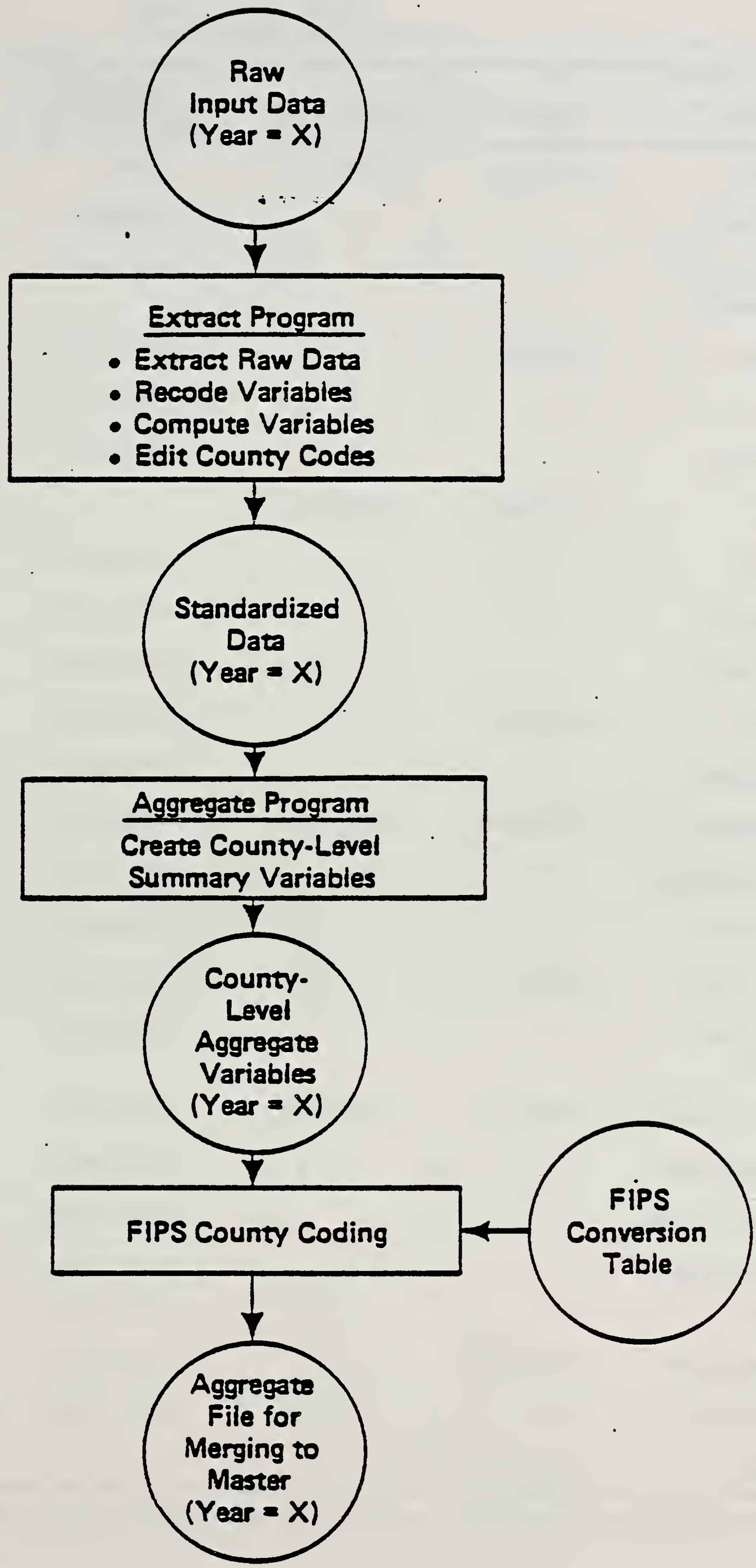

Figure III-1. Flow diagram of vital statistics processing components.

Table III-3

Vital Statistics Data

State	Birth	Infant death	Matched birth/death	Fetal death
Arizona	1974-1979	1974-1979[a]	1980	1970-1981
Colorado			1977-1980	1975-1980
District of Columbia			1972-1980	1977-1981
Georgia	1974-1981		1974-1979	1972-1981
Idaho			1972-1981	1972-1981
Illinois			1975-1980	1972-1981
Iowa	1972-1981	1972-1981		1972-1981
Kansas			1972-1981	1972-1981
Kentucky			1972-1981	1972-1981
Louisiana			1976-1980	1976-1979
Maine	1980-1981		1972-1980	1968-1980
Michigan			1972-1980	
Minnesota	1977-1980	1977-1980	1972-1976	
Mississippi			1975-1980	1975-1980
Missouri			1972-1981	1972-1981
New York	1972-1980		1972-1980	1972-1981
New York City			1972-1981	1972-1981
North Carolina	1968-1981	1968-1981	1968-1979	1968-1981
Pennsylvania			1972-1980	1972-1980
Rhode Island			1976-1980	1976-1980
South Dakota			1972-1980	
Utah			1972-1981	1972-1981
Washington	1972-1981		1972-1981	1972-1981
Wisconsin			1972-1981	1972-1981
NCHS	1972-1979			

[a]Link file with birth/death certificate and dates of birth and death.

Table III-4

NCHS Birth File

State	1972	1973	1974	1975	1976	1977	1978	1979
Arizona	X	X	X	X	X	X	X	X
Colorado	X							
District of Columbia	X	X	X	X	X	X	X	X
Georgia	X	X	X	X	X	X	X	X
Idaho	X	X	X	X	X			
Illinois	X	X						
Iowa	X	X						
Kansas	X	X						
Kentucky	X	X	X	X				
Louisiana	X	X	X					
Maine								
Michigan	X							
Minnesota	X	X	X	X				
Mississippi	X	X	X	X	X	X	X	
Missouri								
New York	X							
New York City	X	X	X	X	X			
North Carolina	X	X	X					
Pennsylvania	X	X	X	X	X	X	X	
Rhode Island								
South Dakota	X	X	X	X	X	X	X	X
Utah	X	X	X	X	X	X		
Washington	X	X	X	X	X	X		
Wisconsin	X	X	X					

X = 50% Sample.
Blank space under each year are the years for which NCHS has 100 percent birth records for the State.

Table III-5

NCHS Birth File: Years of Missing Data by State for the Following WIC Study Variables

State	MEDUCAT	MDOLF.	MDOLMP	MMONCARE	MVISTS	CLEGIT
District of Columbia	72	72				
Georgia	72	72,73	72	72	72	72-79
Idaho	72-77	72-77	72-77	72-77	72-77	72-77
Louisiana		72-79				
Michigan						78-79
New York					72-75	72-79
Pennsylvania	72-75	72-77	72-77	72-77	72-77	
Washington	72-79					
Wisconsin			72-77			

MEDUCAT = Mother's Education

MDOLLB = Date of last live birth

MDOLF = Date of last fetal death

MDOLMP = Date of last menstrual period

MMONCARE = Month prenatal care began

MVISITS = Number of prenatal visits

CLEGIT = Legitimary of child (recode of marital status)

ration, and file delivery steps. This permitted analysis of data inconsistencies (e.g., North Carolina does not provide mother's race; therefore, infant's race had to be used for the birth/infant death and fetal death data); for the preliminary aggregate files, adjustments were made to accommodate these special cases, and additional adjustments were made in the final analysis file.

5. <u>Acquisition of Census and Area Resource File Data</u>

In addition to vital statistics and WIC program data, Census and Area Resource File tapes were used as sources of population and income data and other supporting information for the years 1970 to 1980. RTI had previously purchased 1970 and 1980 U.S. Census tapes for general use and for this

project purchased August 1978 and August 1982 Bureau of Health Professions Area Resource File (ARF) tapes from the U.S. Department of Health and Human Services/Health Resources and Services Administration.

Census population and income data were read from 1970 Second and Fourth Count Tapes and 1980 Summary Tapes STF1A and STF3A. The ARF tapes were used to obtain birth, fetal death, and infant death data for several years of the 1970-1980 decade; population data for 1970 and 1975; AFDC and other assistance data; and other items such as county urbanization codes, county elevation in feet, FIPS codes of contiguous counties, and hospital information. Unpublished distributions of duration of pregnancy were obtained from NCHS for use with birth and fetal death data to estimate total women pregnant during each year.

From these data, counts or estimates of pregnant women for all of the years of the 1970-1980 decade were developed. A listing and format of the Census and ARF derived data and explanations of the computations that were used to develop synthetic data where necessary are included as part of the data file documentation.

6. Conclusions

Table III-6 provides a summary of the data files available for use in the Historical Study analysis. The years of data availability are given for the 21 States that provided both WIC program data and vital statistics data. This list of 21 is further reduced if the WIC data, matched birth/infant death data, and fetal death data are considered essential across all years of interest.

C. DEFINITION OF VARIABLES

1. Overview

This section lists and defines the variables included in this study of the relationship between participation by women in the WIC program during pregnancy and perinatal outcome. The specific outcome or dependent variables are discussed first, followed by a discussion of the independent variables.

2. Dependent Variables

The outcome variables were those that could be derived from the birth and death certificates for each year 1972 through 1980 for each of the U.S. counties included in the study. The principal outcome variables were:

- Mean birthweight in grams.
- Percent of births less than 1,501 grams.
- Percent of births less than 2,501 grams.

Summary of Data Available
for the Historical Study

State	Years of program coverage[a]	Years of WIC data availability	Years of matched birth/infant death data	Years of fetal death data
Arizona	1974-1981	1974-1981	1974-1980	1970-1981
Colorado	1974-1981	1974-1981	1977-1980	1975-1980
District of Columbia	1981	1981	1972-1980	1977-1981
Georgia	1973-1981	(1979-1981)	1974-1979	1972-1981
Idaho	1974-1981	1974-1981	1972-1981	1972-1981
Illinois	1974-1981	1974-1981	1975-1980	1972-1981
Iowa	1974-1981	(1975-1981)	1972-1980	1972-1981
Kansas	1974-1981	1974-1981	1972-1981	1972-1981
Kentucky	1974-1981	1974-1981	1972-1981	1972-1983
Louisiana	1974-1981	1974-1981	1976-1980	1976-1979
Maine	1974-1981	1974-1981	1972-1980	1968-1980
Michigan	1974-1981	(1975-1981)	1972-1980	None
Mississippi	1974-1981	(1975-1981)	1975-1980	1975-1980
Missouri	1974-1981	(1974-77,1979-81)	1972-1981	1972-1981
New York	1974-1981	1974-1981	1972-1980	1972-1981
North Carolina	1974-1981	1974-1981	1968-1979	1968-1981
Pennsylvania	1974-1981	1974-1981	1972-1980	1972-1980
Rhode Island	1974-1981	1974-1981	1976-1980	1976-1980
South Dakota	1974-1981	(1978-1981)	1972-1980	None
Utah	1976-1981	1976-1981	1972-1981	1972-1981
Washington	1974-1981	1974-1981	1972-1981	1972-1981

Note: Years in parentheses indicated incomplete data availability. Birth data are available for all States for the years 1972-1980.

[a]Years in which one or more counties reported as being served.

- Mean duration of gestation in weeks.
- Percent of births with duration of gestation less than 33 weeks.
- Percent of births with duration of gestation less than 37 weeks.
- Fetal deaths at or over 28 weeks duration of gestation per 1,000 live births.
- Early neonatal deaths (0 to 6 days) per 1,000 live births.
- Total neonatal deaths (0 to 27 days) per 1,000 live births.
- Postneonatal deaths (28 to 364 days) per 1,000 live births.
- Percent of live births for which mother registered for prenatal care in the first trimester of pregnancy.
- Percent of live births for which mother had <u>inadequate prenatal care</u>.

The definition of inadequate prenatal care used an algorithm taken from Gortmaker (1979) and Kessner et al. (1973). It is based on number of visits for prenatal care and duration of gestation as follows:

<u>Adequacy of Prenatal Care Index</u>

Code	Gestation in weeks	Number of prenatal care visits
Inadequate	17-21	0
	22-29	≤ 1
	30-31	≤ 2
	32-33	≤ 3
	≥ 34	≤ 4
	Missing	0
Adequate	17-21	≥ 1
	22-29	≥ 2
	30-31	≥ 3
	32-33	≥ 4
	≥ 34	≥ 5
	Missing	≥ 5
Missing	Missing	1-4
	Any number	Missing

While earlier studies used the trichotomy of inadequate, intermediate, and adequate prenatal care, their results suggested that the only appreciable difference in outcome was for those who had inadequate numbers of visits versus the two other groups. This study therefore used the dichotomy of indadequate prenatal care versus others. For both indices of prenatal care, the denominator included only women for whom valid numerator data were available. (This was applied as a general rule throughout the analysis.)

3. Independent Variables

The independent variables are county, year, and a combined WIC and CSFP penetration index.

WIC Penetration Index

The WIC penetration index is defined simply as the ratio of the number of pregnant women who were newly certified for WIC program participation in a given county during a given year to the total number of pregnant women in the same county during the same year who were eligible for the WIC programs (i.e., who would have been certified to participate had they applied). Because neither the numerator nor the denominator of this ratio is known exactly, they had to be estimated.

What was known for the WIC program was period prevalence, or the number of women being served during any 1 month, whether newly or previously enrolled. Moreover, the count included postpartum as well as pregnant women because the program's administrative requirements were that the total number of women in any one WIC agency or program receiving benefits during that month were to be reported, whether they were pregnant or postpartum.

Despite the failure of the WIC program service data to provide directly the requisite county measures of incidence of participation--i.e., counts of new participants during the years of interest--the available prevalence counts provided the basic data for estimating the numerator of the WIC penetration index.

First, counts of women enrolled in WIC agencies serving more than one county were allocated to each county in proportion to the number of women 15 to 44 years of age in families in the county with income below 195 percent of the poverty level. The number of women registered for service in each county at any time during four 1-month periods in each year (March, June, September, and December) were then averaged. Third, these total prevalence counts were adjusted for duration of prepartum and postpartum service. To do so, it was assumed that enrolled pregnant women receive an average of 5 months of prepartum and 8 months of postpartum WIC benefits and that an incremental recruitment of some 10 percent additional women postpartum receive on average 6 months of benefits. With these assumptions, the estimated monthly prevalence of pregnant women receiving WIC benefits reduces to 0.3676 of the average total count of women served per

month. Since an average of one-fifth of the prevalent count of pregnant women would be newly certified participants each month, the estimated annual incidence of pregnant women in each county (i.e., the desired numerator of the WIC penetration index) was computed to be $12/5 \times 0.3676 \times n$, where n is the average monthly count of total women served.

The denominator of the WIC penetration index, the number of eligible pregnant women, was estimated from the United States Census and vital statistics records by calculating the proportion of child-bearing-age women in families with incomes under 195 percent of poverty level (the upper limit for WIC eligibility during the period covered by this evaluation) and multiplying that proportion, for each year and within each county, by the total number of births.

Estimates of penetration of the WIC program assume no systematic variation in either the proportion of pregnant women served or the average duration of service during pregnancy and postpartum.*

On the other hand, random variation in prepartum and postpartum service would tend to lower the statistical significance of relationships. The assumptions are therefore inherently conservative: they lead to underestimation and not overestimation of relationships of WIC service with outcome. With more precisely measured penetration, estimated relationships should be of greater magnitude and of more significance.

Systematic errors in the estimates of the proportion of pregnant women served and the length of service prepartum and postpartum directly affect the magnitude of estimated program outcome effects, but not statistical significance. Thus, if estimates are wrong on the average duration of WIC services in pregnancy or the proportion of women served who were postpartum, the estimated effects will be proportionately in error (if service in pregnancy was actually longer or the proportion of postpartum service was actually greater than predicated, estimates of effect would be low, and vice versa).

<u>CSFP Penetration Index</u>

Counts of CSFP participants were obtained from administrative data sent to FNS, and subsequently issued by FNS as monthly reports. Yearly estimates of service were derived from the numbers of women served during the same 4 calendar months used to estimate WIC penetration. CSFP participation data were already aggregated by county, so the allocation procedure used for multicounty WIC agencies was unnecessary. Participation by women, infants, or children were not specified separately. Therefore, the nationwide ratio of women among all CSFP participants for each separate month

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*An example of systematic variation would be if birthweights were higher in WIC programs which served a lower proportion of pregnant women. Such relationships, while possible, are implausible.

(around 20 percent over the study period) was used in all counties to estimate the number of participating women.* For December 1979 through September 1980, the actual number of participating women was known and therefore was used. The number of counties with CSFP declined during the study period, from a maximum of 165 in 1972 to only 12 in 1980.

CSFP and WIC penetration rates were computed using the same algorithm. In the final computation of these rates, both WIC and CSFP participation were lagged 3 months forward so that service to the pregnant women was more closely associated with the date of the delivery of her child. Penetration for WIC and CSFP by county by year were summed to form a single index, combined WIC and CSFP penetration. The presence of either WIC or CSFP in a county was also incorporated into a single binary variable.

D. ANALYTIC METHODS

1. The Model

A regression model was used to estimate the effect of WIC penetration. The dependent variables were indices of prenatal care, duration of gestation, birthweight, and fetal and infant mortality for each county and year. The independent variables were a set of indicator variables representing county effects, a set of indicator variables representing time effects, and a continuous independent variable, the WIC penetration rate for each county and year. The model can thus be written as

$$y_{ij} = \mu + C_i + T_j + \beta W_{ij} + \varepsilon_{ij}$$

where

y_{ij} = the value of the dependent variable (e.g. mean birthweight) for the ith county in the jth time period

μ = an overall effect which reflects the mean level of the dependent variable over all counties and time periods

C_i = the effect of the ith county on the dependent variable

T_j = the effect of the jth time period on the dependent variable

β = the regression weight associated with the WIC penetration rate

W_{ij} = the WIC penetration rate for the ith county in the jth time period

ε_{ij} = the unexplained residual or error associated with the ith county in the jth time period.

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*Any variation from a constant proportion across counties would tend to weaken estimates between WIC participation and outcome and again, is inherently conservative.

The model assumes three sources of variation for the dependent variable: county, time, and WIC penetration rate. Three major hypotheses can be tested:

- C_i, the county effects, are all equal
- T_j, the time effects, are all equal
- $\beta = 0$.

The statistical hypothesis of primary interest is the last one, $\beta = 0$. Because of wide variation in most dependent variables across counties and time, it would be expected that both of these sources of variation in the dependent variable would be highly significant. In fact, this was the case. The important question is whether β, the regression parameter associated with WIC penetration is significantly different from zero after being adjusted for the effects of county and time.

Counties vary enormously in population as well as in levels of poverty. The contribution of each county was thus weighted both by the number of births and the relative poverty of its inhabitants. Each county's contribution was weighted by the square root of the number of births in 1976, the midpoint of the series, and by the proportion of families including women aged 15 to 44 with incomes under 195 percent of the poverty level in 1976. Weighting by the square root of the number of births, rather than the number of births, was meant to give more weight to larger counties, but not so much that the contribution of small counties was overwhelmed.

A complication of analyzing pooled, cross-sectional, and time-series data is that the errors may not be independently distributed within a county across time, although the errors across counties are assumed to be independent. That is, for any i (county), the ε_{ij}'s may be correlated.

The weighted least squares estimate of β, the WIC penetration parameter, is an unbiased estimate even in the presence of autocorrelated errors. However, the error sum of squares is usually underestimated so that the F ratio is biased upwards and results in an overstatement of significance. In order to generate a proper test of significance, it was decided that for each analysis where β was significant at the .10 level, the autocorrelations among the errors would be estimated and be used to reestimate β and properly test for its statistical significance. The analytical approach (Kenny, 1984) assumed that the errors within each county could be accounted for by a first order autoregressive model: $\varepsilon_{ij} = \rho\varepsilon_{i,j-1} + \delta_{ij}$, where ρ is the autocorrelation between the ε_{ij}th and $\varepsilon_{i,j-1}$th errors, and δ_{ij} is a normally and independently distributed error with constant variance across time and counties. The residuals from the weighted least squares fit were used to estimate ρ. The dependent variable y_{ij} was then transformed into $y_{ij} - \hat{\rho}y_{i,j-1}$, and the WIC penetration rate was transformed into $W_{ij} - \hat{\rho}W_{i,j-1}$. The model was rerun with these transformed independent and dependent variables so that β could be re-estimated and properly tested for

statistical significance. Note that when $\hat{p}$ is small, the transformation has little effect on either the WIC penetration rate or the dependent variable.

2. <u>Sample Size Limitations</u>

The availability of the data elements required for this study are described by State in Table III-7. The subsequent analyses included those States with data in relatively easily accessible form. Since this study has no precedent, the parameters that would have allowed formal power analysis, in order to judge necessary sample size, did not exist. To calculate required study sample size, both estimates of the size of the program effects that would be reasonable and worthwhile and of the variability of outcomes are necessary. Estimates of variability were not available. Therefore, there was only weak justification in expending the considerable time and resources to gather data from States with less easy access in order to increase the sample size.

Data from five States (Georgia, Louisiana, Michigan, Mississippi, and South Dakota) have been analyzed separately because WIC and CSFP service data for these States were available for some, but not all, years under study. For five important outcomes (fetal death rate, rate of preterm delivery, mean duration of gestation, mean birthweight, and neonatal death rate), WIC penetration has been related to outcome within each State as independent tests of overall results. These analyses are presented in Volume IV, Appendix III-D.

Data on fetal death were available for four of these States. To get the best possible estimate of WIC program effect on fetal death, a method has been developed for combining the results for these four States with those of States with complete data in a single analysis.

There were 71 counties with fewer than 50 births in 1976, the midpoint of the series. These were excluded from analysis in order to increase the stability of estimates, since chance variation increases as the number of births decreases. Multiple births were included in the county level analyses, as well as births of "other" races, of unknown race, and with unknown maternal education. Analyses for subgroups stratified by maternal education and race were limited to singleton white or black births, in which the mother's education was known.

The number of counties included in the analyses of different dependent variables differ according to the availability of outcome data. The regression analysis required complete data for the entire time series. For some States (Arizona, Colorado, Illinois, Kansas, Maine, Rhode Island, Utah) and New York City, data on infant death were either unavailable for the entire period or the data acquired from the State (Kansas, Utah, and New York City) differed markedly from the rates reported by the NCHS. The analyses of infant mortality thus include the smallest number of counties (n=582). Birthweight was available for all counties with complete penetration data (n=888). Pennsylvania, Washington, and the District of Columbia

Table III-7

Availability of Study Data, by State

	Years Penetration Unavailable	Years Outcome Not Available: Prenatal Care: 1st Trim Entry	Prenatal Care: Inadequate Care	Duration of Gestation	Birth Weight	Mortality: Fetal	Mortality: Infant	Analysis By Education and Race Possible
Arizona	-	-	-	-	-	72-80	72-79[a]	Yes
Colorado	-	-	-	-	-	72-74	72-76	Yes
Dist. of Columbia	-	-	-	-	-	72-76	-	1973-
Georgia	74-78	72	72	72	-	72-80[a]	72-80[a]	1973
Illinois	-	-	-	-	-	-	72-74	Yes
Iowa	-	-	-	-	-	-	-	Yes
Kansas	-	-	-	-	-	-	72	Yes
Kentucky	-	-	-	-	-	-	-	Yes
Louisiana	75-76	-	-	-	-	-	72-75	Yes
Maine	-	-	-	-	-	-	72	Yes
Michigan	74-76	-	-	-	-	72-80	-	Yes
Mississippi	74-75	-	-	-	-	72-74	72-74	Yes
Missouri	b	-	-	-	-	-	-	Yes
New York State	-	-	72-75	-	-	-	-	Yes
New York City	-	-	-	-	-	-	72-80[a]	Yes
North Carolina	-	-	-	-	-	-	-	Yes
Pennsylvania	-	72-77	72-77	72-77	-	-	-	No
Rhode Island	-	-	-	-	-	72-75	72-75	Yes
South Dakota	75-77	-	-	-	-	72-80	-	Yes
Utah	-	-	-	-	-	-	72,80[a]	Yes
Washington	-	-	-	-	-	-	-	No

[a]Available, but inconsistent with published report.

[b]1978 rate estimated by linear interpolation of 1977 and 1979 penetration.

were not included in the subgroup analyses because maternal education was not available on the birth certificates.

3. Estimation of WIC Effects

The estimated regression weight $\hat{\beta}$ measures the amount of change in the dependent variable associated with a 1-percent increase in the WIC penetration rate. The effect of increasing the WIC penetration rate from 0 to 39 percent (the average 1980 WIC penetration rate) is estimated for an outcome as $\hat{\beta} \times 39$. This estimated effect of going from zero to the average 1980 WIC penetration is one of the effect parameters presented in the statistical tables of results in this chapter. The effect of WIC penetration stated in this way is considered easier to interpret at first glance than the estimated regression parameter itself. A second estimate of the effect of the WIC program is also presented in the tables under the assumption that the entire county level effect at 100 percent WIC penetration is contributed only by WIC recipients and accrues entirely to them. It is reasonable to assume that the effects of WIC during the period under study were exhibited only by those women who received WIC benefits. This analysis estimates how large the effect would have been if it is confined to WIC participants. Further justification for this estimate is given in Appendix III-E of Volume IV.

In addition to analyses of the relationship of WIC program penetration to each of the outcome variables, several composite outcome variables were created and analyzed. Thus, WIC penetration was also related to the rate of birthweight under 2,501 grams among births at less than 37 weeks duration and more than 37 weeks duration, since the WIC program should have greater effect on the frequency of low birthweight among term births, a function of decelerated fetal growth, than on the frequency of low birthweight among preterm births. The latter reflects not only fetal growth retardation, but preterm delivery, which is likely to be less responsive than fetal growth retardation to the nutritional components of the WIC program. Rates of neonatal mortality were also assessed separately among infants of different birthweight (less than 1501 g, 1501-2500 g, greater than 2500 g). The hypothesis was that if the WIC program did affect neonatal mortality, the effect would be mediated by increased birthweight, and that effects on mortality within birthweight strata would therefore be smaller than the overall effect. These analyses were not done for subgroups of births, stratified by maternal race and education, but only among all births in each county, given the reduced number of births in each of the analyses.

4. Subgroup Analyses

WIC is targeted at low-income women who are judged to be at nutritional risk. Analysis at the county level estimates average benefits for the entire population of the county. A more sensitive analysis would be to estimate program effects for subgroups of mothers more likely to have been enrolled in, and responsive to, the program. Therefore, the effects of WIC were estimated on four groups of births, defined by maternal race (white and black) and years of education (fewer than 12 years and 12 or more

years). Maternal race and education are known from birth certificates, but income and nutritional status are not.

These subgroup analyses are of some help in judging whether there was confounding of the effects of the WIC program by health care. While some improvements in health care, such as the Maternal and Infant Care Projects (MIC), are targeted at poor women also eligible for the WIC program, these programs have served limited numbers of women. The greatest changes in perinatal health have followed from improved services around the time of birth (monitoring, transport, regionalization of services, intensive neonatal care, etc.). These are services available to the entire community, and if past history is a reasonable guide, they are more likely to be used by the more educated and affluent than the less educated and the poor. Thus, if the relationships between WIC penetration and perinatal outcome are greater among the less educated and blacks, confounding by health care is less likely than if associations are greater among whites or the more educated.

The subgroup analyses are limited to singleton births. Only counties with more than 50 births in 1976 of the particular subgroup under study were included in each analysis. The number of counties included in each of the subgroup analyses was thus reduced, particularly for blacks. While the outcomes are specific to each particular subgroup, the estimate of WIC penetration is still that for the total county population.

E. RESULTS

1. WIC Penetration and Presence

The average estimated rates of penetration for WIC and CSFP for the years under study are presented in Table III-8. From 1972 to 1980, the

Table III-8

Penetration due to WIC and CSFP by Year

Year	WIC penetration	CSFP penetration	Total penetration	Percent of total penetration due to CSFP
1972	0.00	0.03	0.03	100
1973	0.00	0.03	0.03	100
1974	0.02	0.02	0.04	68
1975	0.06	0.02	0.08	25
1976	0.06	0.02	0.08	20
1977	0.13	0.01	0.14	6
1978	0.19	0.01	0.20	4
1979	0.24	0.01	0.25	0.3
1980	0.38	0.01	0.39	0.2

summed penetration of WIC and CSFP rose from 3 percent of the eligible population (or about 1 percent of all births) to nearly 40 percent of the eligible population (or about 13 percent of all births).

In addition to the 15 States included in the central analysis, there were 5 States for which counts of women served by the WIC program were missing for some years, but in which it was known if a WIC program existed in a county during all years of study. Two independent variables were used initially, WIC presence in a county, for all 20 States, and WIC penetration for the 15 States in which counts of women served were available for all years. While all the relationships of outcome with presence of WIC were in the same direction as were those for penetration, they were of lower magnitude, and none approached statistical significance. It became obvious that the presence variable accounted for far less variance in outcome than did penetration, and subsequent analyses were therefore limited to those of WIC penetration, including all that will be reported in the body of this report. Consequently, most of the analyses concentrated on those 15 States with complete data for making both WIC penetration estimates and outcome estimates at the county level for all 9 years.

2. Change in Outcome Over Time

The period of this study was one of improvement in perinatal outcome in this country. Although not the central issue to which this study is addressed, it is of interest to present some information on the changes that occurred in the 15 States in the central analyses of the study. Means for all dependent variables under study over the course of these 9 years are presented in Table III-9. The county means are across all available counties, and because they were derived from our central analyses, they are also weighted by the square root of the number of births in the county in 1976. (The means weighted by number of births, i.e. the population means, are nearly identical.)

These changes over time are the background against which the effects of the WIC program are estimated. While these changes are, in part, a function of the effects of the WIC program, the contribution of WIC is a small component of most of these changes, because even in the last year of study only about 13 percent of all births were to mothers enrolled in the WIC program; as late as 1976, under 3 percent of all births were to women enrolled in the program. Rather, the data are presented to show how great the changes were over this period and the concurrent necessity to account for change over time in any attempt to estimate the effects of the WIC program. Clearly, many other things were concurrently influencing perinatal outcome in these States. Another reason for close attention to these data is to compare the types of effects from WIC with those occuring generally. While such health care changes as fetal monitoring (with consequent obstetrical intervention), transport of sick neonates, and intensive neonatal care might be expected to influence intrapartum and neonatal death rates, they should have little or no influence on duration of gestation or on birthweight. Thus, the pattern of effects of WIC is very important in judging whether the WIC program is either a simple conduit of improved health care or has had effects specific to a predominantly nutritional

Table III-9

Study Outcomes by Year[a]

Year	Prenatal care: %1st Trimester entry	Prenatal care: % Inadequate	Duration of gestation (w): % <33	Duration of gestation (w): % <37	Duration of gestation (w): Mean	Birthweight (g): % <1501	Birthweight (g): % <2501	Birthweight (g): Mean
1972	70.00	8.66	2.24	7.27	38.95	1.05	7.28	3309.56
1973	71.31	7.68	2.11	6.89	39.02	1.04	7.18	3313.09
1974	72.70	6.71	1.99	6.31	39.16	1.06	7.06	3318.79
1975	73.19	6.40	2.06	6.53	39.09	1.03	6.97	3323.95
1976	74.31	5.77	1.99	6.43	39.08	1.05	6.92	3338.80
1977	74.70	5.46	1.93	6.35	39.09	1.01	6.64	3345.17
1978	75.57	5.67	1.96	6.54	39.05	1.04	6.61	3347.26
1979	76.50	5.23	1.91	6.56	39.03	1.02	6.52	3354.70
1980	77.19	5.00	1.92	6.37	39.03	1.03	6.37	3359.28
N:Counties	822	765	822	822	822	888	888	888

Year	Mortality/1000: Fetal	Mortality/1000: Neonatal Early (0-6d)	Mortality/1000: Neonatal Total (0-27d)	Mortality/1000: Post neonatal (28-364d)	Birthweight specific neonatal mortality/1000: <1501g	Birthweight specific neonatal mortality/1000: Birthweight 1501-2500g	Birthweight specific neonatal mortality/1000: >2500g	% Birthweight <2500 g by duration of gestation: <37w	% Birthweight <2500 g by duration of gestation: 37w+
1972	7.33	11.77	13.12	4.07	592.24	67.80	6.80	39.99	3.49
1973	7.24	11.11	12.56	3.98	550.66	62.35	6.85	40.36	3.53
1974	6.89	10.60	12.21	4.06	576.86	57.33	6.53	42.63	3.46
1975	6.22	9.94	11.63	3.85	553.53	54.01	6.23	40.99	3.37
1976	6.05	9.14	10.70	3.62	539.63	47.08	5.66	41.84	3.27
1977	5.69	8.03	9.54	3.70	509.80	43.34	5.56	40.95	3.11
1978	5.59	7.71	9.17	3.73	487.35	38.99	5.27	39.86	3.06
1979	5.53	7.20	8.57	3.76	505.36	37.24	5.06	39.29	3.01
1980	5.40	6.66	7.84	3.17	468.34	34.50	4.38	39.29	2.93
N:Counties	819	582	582	582	292	565	582	788	822

[a]The outcomes are the mean of county means, weighted by the square root of number of births in 1976, the mid year in the series.

program with effects on prenatal life rather than perinatal events. If this is true, such prenatal effects would be on duration of gestation, birthweight, and prepartum fetal death, none of which are easily influenced, or influenced at all, by the revolution in high technology perinatal care.

Over these 9 years, there were great changes in the indices under study. The proportion of women entering prenatal care in the first trimester rose from 70 to 77 percent, and the rate of inadequate numbers of prenatal visits fell from 8.7 to 5.0 percent. While there is a general impression that duration of gestation and birthweight have been fixed over time, this is not true. The rate of delivery under 33 weeks gestation fell from 2.24 per hundred to 1.92 per hundred, a reduction of 14 percent. Preterm delivery (under 37 weeks gestation) fell by 12 percent, low birthweight (under 2,500 g) fell by 12.5 percent, and mean birthweight rose by (a remarkable) 40 grams. These secular trends reflect, in part, growth of the WIC program. Estimates of WIC effects after removing the secular trends are therefore underestimates.

The decreased incidence of low birthweight over the study period was exclusively among term births, among whom the incidence of low birthweight fell about 16 percent. Thus, reduction in low birthweight was due both to fewer preterm deliveries and to accelerated growth, but only among term births. These changes are consistent with improvement in prenatal health, not only in improvements in perinatal care, as is the remarkable fall of 26 percent in fetal mortality, only a small part of which was likely due to decreased intrapartum fetal death in response to improved perinatal care (fetal monitoring, prompt intervention, etc.).

Table III-10 presents means for all dependent variables over the study period for the four subgroups defined by race and maternal education. Among blacks and the less educated, a considerably higher proportion of women were eligible for the WIC program; WIC may well have contributed appreciably to secular change in the birth outcome for such women.

The estimated penetration of the WIC program for all States in the study for each year is presented in Table III-11. Four States started the study period with appreciable penetration (from 6 to 12 percent of eligible births), all from CSFP. By 1980, two States (Arizona and Rhode Island) had penetration over 60 percent, two (Colorado and North Carolina) between 50 and 60 percent, and three (Kansas, South Dakota, and Utah) under 30 percent. The other 12 States were all between 32 and 45 percent penetration.

3. Form of Results

The tabular presentation of the principal results is consistent (see Tables III-13 through III-16). The population mean across all counties and for all 9 years, weighted only by the square root of numbers of births at the midpoint of the time series, 1976, is presented in the first row of each table. The yearly change in the index over the course of the period and the statistical significance of that change is in the second row. The

Table III-10

Study Outcomes by Subgroup and Year

	Prenatal Care							
	First Trimester Entry				% Inadequate			
	Race				Race			
	White Education (yrs)		Black Education (yrs)		White Education (yrs)		Black Education (yrs)	
Year	<12	12+	<12	12+	<12	12+	<12	12+
1972	58.68	77.92	41.87	54.97	13.23	4.66	24.45	14.32
1973	59.54	79.24	43.09	56.71	12.20	3.96	22.48	13.07
1974	60.31	80.38	45.04	59.14	11.28	3.29	21.50	12.14
1975	60.26	80.78	47.36	61.00	10.80	3.05	20.31	11.13
1976	60.64	81.72	49.54	62.55	10.09	2.74	18.05	10.47
1977	60.61	81.92	49.75	63.40	9.84	2.65	17.71	9.75
1978	61.81	82.43	50.00	64.47	10.50	2.75	18.27	9.93
1979	62.18	83.27	51.44	65.63	9.61	2.59	17.56	9.44
1980	63.03	83.62	52.61	66.90	9.61	2.46	17.37	8.74
N	475	730	110	118	420	674	98	106

Duration of Gestation (w)

	% <33				% <37				Mean			
	Race				Race				Race			
	White Education (yrs)		Black Education (yrs)		White Education (yrs)		Black Education (yrs)		White Education (yrs)		Black Education (yrs)	
Year	<12	12+	<12	12+	<12	12+	<12	12+	<12	12+	<12	12+
1972	2.55	1.40	5.92	4.54	8.39	5.34	14.79	11.17	38.96	39.13	37.94	38.13
1973	2.35	1.37	5.81	3.88	7.97	5.05	14.30	10.37	39.11	39.24	37.98	38.36
1974	2.26	1.26	5.33	3.73	7.42	4.65	12.84	9.96	39.22	39.43	38.21	38.47
1975	2.42	1.28	5.81	3.80	7.71	4.80	13.87	9.85	39.12	39.30	38.09	38.44
1976	2.37	1.20	5.65	3.48	7.67	4.76	13.50	10.06	39.17	39.33	38.13	38.48
1977	2.30	1.18	5.60	3.53	7.30	4.81	13.21	9.88	39.17	39.28	38.13	38.43
1978	2.39	1.18	5.95	3.79	7.56	4.94	13.86	10.10	39.16	39.25	38.06	38.39
1979	2.36	1.19	5.62	3.69	7.50	4.97	13.95	9.96	39.16	39.22	38.09	38.41
1980	2.28	1.21	5.61	3.78	7.54	4.86	13.58	10.04	39.15	39.21	38.11	38.42
N	475	729	110	118	475	729	110	118	475	729	110	118

(continued)

Table III-10 (continued)

--- Birthweight (_) ---

Year	% <1501 Race: White education <12	(v) 12+	Black education <12	(y) 12+	% <2501 Race: White education <12	(v) 12+	Black education <12	(y) 12+	Mean Race: White education <12	(y) 12+	Black education <12	(y) 12+
1972	1.03	0.61	2.30	1.93	7.98	4.91	13.94	11.55	3280.07	3379.79	3055.93	3117.31
1973	1.02	0.64	2.34	1.87	7.91	4.82	14.04	10.89	3280.87	3383.22	3052.27	3131.86
1974	1.05	0.63	2.18	1.74	7.88	4.75	14.87	10.87	3280.25	3389.92	3054.02	3131.87
1975	1.01	0.60	2.44	1.91	7.75	4.60	14.39	10.49	3281.83	3397.60	3045.46	3138.46
1976	1.05	0.61	2.33	1.73	7.67	4.61	13.65	10.52	3290.50	3413.93	3058.58	3151.64
1977	1.03	0.61	2.31	1.90	7.47	4.49	13.68	10.30	3294.93	3417.02	3065.31	3160.37
1978	1.08	0.61	2.56	1.97	7.52	4.39	13.79	10.46	3287.07	3422.82	3055.68	3156.94
1979	1.04	0.61	2.53	1.86	7.49	4.31	14.10	10.15	3291.59	3429.65	3057.25	3165.28
1980	1.07	0.65	2.32	1.99	7.46	4.27	13.70	10.12	3283.48	3434.48	3062.05	3164.98
N	475	730	110	118	475	730	110	118	475	730	110	118

--- Mortality/1000 livebirths ---

Year	Fetal Race: White education <12	(v) 12+	Black education <12	(y) 12+	Early Neonatal (0-6d) Race: White education <12	(v) 12+	Black education <12	(y) 12+	Neonatal (0-27d) Race: White education <12	(y) 12+	Black education <12	(y) 12+	Postneonatal (28-364d) Race: White education <12	(y) 12+	Black education 12	(y) 12+
1972	7.67	5.71	11.43	9.03	12.56	8.66	19.62	15.07	14.35	9.65	22.84	16.98	5.73	2.63	11.40	5.82
1973	7.25	5.73	11.01	10.34	11.18	8.42	16.41	13.87	13.12	9.46	18.78	15.49	5.41	2.53	10.61	4.72
1974	6.55	5.31	10.17	9.16	11.08	7.40	15.85	11.30	12.88	8.72	18.33	12.50	6.24	2.74	10.35	5.90
1975	5.34	4.86	8.70	7.53	10.00	7.44	14.79	12.69	11.94	8.83	17.87	14.71	5.58	2.90	11.07	4.49
1976	5.38	4.94	6.44	7.50	10.21	6.60	13.18	12.03	11.73	7.86	15.26	13.79	5.48	2.59	10.64	5.05
1977	5.54	4.53	6.80	7.34	8.51	5.95	13.22	11.50	10.41	7.06	16.25	13.49	5.67	2.54	11.71	4.85
1978	4.75	4.59	6.10	7.16	7.53	5.57	12.67	11.33	9.14	6.76	15.90	13.39	5.57	2.60	10.31	5.08
1979	4.68	4.42	5.70	6.90	5.51	5.11	11.71	10.53	8.25	6.08	13.40	11.88	5.24	2.67	10.48	4.63
1980	4.61	4.86	6.07	6.67	6.40	4.83	9.88	10.06	7.87	5.67	11.49	11.18	5.05	2.21	8.13	3.91
N	437	665	105	111	306	445	83	85	206	445	83	86	306	445	83	85

Table III-11

Mean Penetration[a] by State (1972-1980)

State	1972	1973	1974	1975	1976	1977	1978	1979	1980
Arizona	0.03	0.00	0.01	0.15	0.23	0.27	0.38	0.49	0.62
Colorado	0.09	0.10	0.11	0.16	0.17	0.22	0.29	0.40	0.54
Georgia	0.01	0.01	.	.	.	.	.	0.30	0.39
Illinois	0.01	0.01	0.01	0.03	0.05	0.11	0.13	0.21	0.32
Iowa	0.12	0.09	0.06	0.08	0.08	0.14	0.20	0.25	0.37
Kansas	0.02	0.02	0.00	0.01	0.00	0.07	0.10	0.13	0.19
Kentucky	0.00	0.00	0.02	0.04	0.05	0.13	0.22	0.24	0.39
Louisiana	0.03	0.03	0.05	.	.	0.25	0.27	0.35	0.43
Maine	0.00	0.00	0.01	0.03	0.03	0.05	0.28	0.29	0.37
Michigan	0.01	0.02	.	.	.	0.13	0.24	0.30	0.45
Mississippi	0.02	0.03	.	.	0.04	0.10	0.22	0.25	0.35
Missouri	0.04	0.05	0.05	0.06	0.10	0.16	0.16	0.17	0.37
New York	0.01	0.01	0.04	0.07	0.09	0.12	0.17	0.20	0.38
North Carolina	0.06	0.06	0.03	0.06	0.10	0.20	0.33	0.44	0.58
Pennsylvania	0.00	0.00	0.00	0.03	0.08	0.11	0.15	0.17	0.33
Rhode Island	0.00	0.00	0.03	0.12	0.22	0.32	0.39	0.58	0.63
South Dakota	0.01	0.01	0.02	.	.	.	0.08	0.12	0.17
Utah	0.08	0.08	0.08	0.09	0.08	0.08	0.17	0.19	0.25
Washington	0.01	0.01	0.01	0.12	0.16	0.18	0.22	0.30	0.41

[a] Combined WIC and CFSP penetration.

third row is the difference across counties associated with presence of WIC at average national penetration, i.e., the estimated difference between a county at the average penetration of WIC during the entire study period, versus a county which had no WIC program.

In general, between-county differences are highly significant, and in the direction such that counties that were at the mean of WIC penetration over the decade were considerably worse in outcome than those with no WIC penetration. This is straightforward and expected: WIC programs are more likely to exist, and to be larger, in counties with worse outcomes. To that extent, the WIC program was targeted appropriately.

The effect of WIC penetration is presented in two ways in the next two rows: first (in the upper row), the estimated differences in the mean outcome for all births in the county given the mean penetration for 1980, the last year of the time series; and second (in the lower row), the effect among WIC recipients as opposed to the average result for all births in the county, assuming the entire county change was contributed only by those directly served by WIC. Where the probability of the relationship of WIC to the outcome was $p \leq 0.10$, the coefficient of autocorrelation is presented along with the recalculated probability taking into account the coefficient of autocorrelation. (The requisite algebra for this calculation is presented in Appendix III-F of Volume IV.)

The estimates depend on the Census, which found that one-third of all women of childbearing age were in families with incomes under 195 percent of the federally defined poverty level (see Table III-11). (The conversion factor rose to 0.38 from one-third, after weighting the contribution to outcome of each county by the number of WIC eligible women.) One-quarter of white women with 12 or more years of education were in families with incomes below 195 percent of the poverty level, as were half of white women with fewer than 12 years education, half of black women with 12 or more years of education, and three-quarters of black women with fewer than 12 years of education (see Table III-12). The conversion factors for the sub-groups were assumed also to increase proportionately to the increase in the total county proportion of eligible women. The results, formatted as described above, are summarized in four tables, one for each class of outcome variables.

4. Health Care During Pregnancy

The analysis results concerning health care during pregnancy are presented in Table III-13. WIC penetration was accompanied by a highly significant decrease in the proportion of women receiving inadequate prenatal care. The average penetration for 1980 (39 percent of all eligible women served) was associated with a reduction in the proportion of women receiving inadequate care of 8 per 1,000 (the average proportion of women receiving inadequate care over the entire study period was 63 per 1,000). If all change due to WIC was contributed only by direct WIC recipients, 50 fewer per 1,000 WIC recipients would have inadequate prenatal care. This result was significant at the 0.001 level.

Table III-12

Proportion of Women of Childbearing Age (15-44) in Families with Income Below 195% of the Poverty Level

	Percent < 195% of poverty level (cell frequencies in parentheses)		
	Education (years)		
Race	<12	12+	Total
White	49.4 (8356)	24.6 (28532)	30.2 (36888)
Black	77.3 (1432)	51.9 (3037)	60.0 (4469)
Total	53.5 (9788)	27.2 (31569)	33.4 (41357)

( ) = number in sample.

Source: March 1981 Current Population Survey, US Census Public Use Tapes. Survey completed in 1980.

Table III-13

The Effect of WIC on Health Care During Pregnancy

	First trimester registration (%)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	73.94	60.79	81.26	47.96	61.64
Change/year[a]	0.86***	0.48***	0.67***	1.34***	1.46***
Difference between counties at mean versus zero level of WIC penetration	-1.36***	-0.53	0.29	2.48	3.66*
Effect within county, 1980 penetration level versus zero penetration	0.66***	0.33	-0.09	2.82***	1.39*
Effect among WIC recipients, if effect contributed only by them[b]	4.13***	1.35	-0.77	6.69***	4.96*
Coefficient of autocorrelation	0.45	--	--	0.39	0.41
Level of significance of WIC effect accounting for autocorrelation	0.02	--	--	0.003	0.68
Number of counties	822	475	730	110	118

See notes at end of table. (continued)

Table III-13 (continued)

	Inadequate prenatal care[c] (%)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	6.29	10.80	3.13	19.74	11.00
Change/year[a]	-0.42***	-0.41***	-0.24***	-0.87***	-0.65***
Difference between counties at mean versus zero level of WIC penetration	1.07***	0.33	0.20	-3.16**	-1.44
Effect within county, 1980 penetration level versus zero penetration	-0.80***	-0.61*	-0.13	-0.49	0.14
Effect among WIC recipients, if effect contributed only by them[b]	-5.01***	-2.49*	-1.12	-1.14	0.48
Coefficient of autocorrelation	0.49	0.37	--	--	--
Level of significance of WIC effect accounting for autocorrelation	0.0001	0.09	--	--	--
Number of counties	765	420	674	98	106

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Unadjusted.

[b]Assuming county wide effect contributed only by women directly served by WIC.

[c]From Gortmaker (1979) and Kessner et al. (1973); based on number of visits for prenatal care and duration of gestation. See Section C.2.

The proportion of women who registered for care in the first trimester was 739 per 1,000 over the period of the study. At the level of WIC penetration in 1980 (0.39), it was estimated that 6.6 more women per 1,000 were registering in the first trimester; if this change was contributed only by those who received WIC benefits, their increase in the first trimester registration would be 41 per 1,000. This difference was significant at the 0.02 level after accounting for autocorrelation.

Because there were large effects of WIC on measures of prenatal health care, the possibility existed that WIC intervention was confounded with other interventions that led to improved prenatal care. Such confounding would imply that the relation between WIC and health care is not causal. To explore the likelihood of confounding, WIC penetration was related to health care outcomes for the year previous to the penetration value (i.e., relate health care in 1975 to penetration in 1976, etc.). Should the relationship of WIC to past health care be equal to or greater than to current health care, confounding would probably be present. Health care would thus be a "leading indicator" of WIC. The effects of WIC penetration on current health care turned out to be much greater than on past health care. These reduced relationships of WIC to past health care are consistent with the likelihood that the results are not confounded, not only for health care, but also for birth outcome.

This relationship between first trimester registration and WIC penetration is in some small part circular: there must be a correlation between early registration and the penetration index, because penetration is based on a count of prevalent cases and, as duration of prenatal care increases, so does the prevalence of WIC beneficiaries. The effect of this circularity was estimated for the outcomes in scaled units, and the effect was miniscule. While the same algebraic estimate does not apply to outcomes that are proportions or percentages, the effect must also be of small magnitude. Therefore, although early registration would, in small part, lead to higher penetration, the results overall are consistent with strong beneficial effect of the WIC program on prenatal care.

For the subgroup defined by race and education, each analysis was limited to counties where there were at least 50 births in 1976 for the group of births under analysis. Thus, there are many fewer counties in the analyses for blacks (118 for those with 12 or more years of education, and 110 for those with fewer than 12 years of education). The subgroup analyses were for singleton births only, while the total population included all births with known outcome. Also, there were two large States and the District of Columbia which did not have complete data on education and were therefore omitted from the subgroup analyses.

For first trimester entry into prenatal care, the largest and only significant effect was among less educated blacks, the group with greatest need: throughout the decade, fewer than half entered care in the first trimester (in contrast, over 80 percent of more educated whites began prenatal care during the first trimester). The estimated increase among

less educated black WIC recipients was about 67 per 1,000, about a 13.5 percent increase over their basal rate. This difference was significant below the 0.01 level. The effects of WIC for the other three groups were not statistically significant. After accounting for autocorrelation, the effect of WIC on the rate of inadequate prenatal care was statistically insignificant for all four subgroups.

5. Duration of Gestation

The analysis results concerning duration of gestation are presented in Table III-14. Three indices of duration of gestation were studied: the rate of very preterm birth (under 33 weeks duration of gestation at delivery), the rate of preterm birth (under 37 weeks duration of gestation), and the mean duration of gestation, in weeks. There was significant decline in very preterm delivery over the period of study, but not in preterm delivery, nor was there a significant increase in mean duration of gestation. There was no statistically significant effect of the WIC program on the rate of very preterm or preterm delivery. There was, however, a significant relationship with increased mean duration of gestation. The increase in mean duration of gestation associated with WIC, assuming that all change was among those directly served, was 0.2 weeks ($p = 0.03$, after accounting for autocorrelation), or about 1.4 days. This is not an effect of trivial size, and could account for about 30 grams increased birthweight, about the level of WIC effect observed. Again, as with first trimester registration for prenatal care, there is some circularity in this relationship: with longer pregnancy, the prevalence of WIC goes up, and the penetration index will be higher. The estimate is that only one-quarter of 1 percent of the 1.4 days would be due to this circular relationship (longer duration causing higher penetration; see Volume IV, Appendix III-G).

The results stratified by race and education indicate that, as with almost all other outcomes (with the exception of fetal death rate; see below) the relationships of outcome with WIC penetration tend to be greater among women at higher risk.

The basal rates of very preterm delivery are remarkably different across race and education: less educated blacks were four times as likely to deliver before 33 weeks gestation than more educated whites. While there was no significant relationship between WIC penetration and very preterm delivery in the total population, there was a statistically significant ($p = 0.05$) reduction among less educated whites, and of reasonably high magnitude. WIC was associated with a decrease of 7.7 very preterm births per 1,000 deliveries. Since the basal rate among less educated whites was 23.6 very preterm births per 1,000 deliveries, this was a 33 percent reduction. The pattern is consistent with greater effect among those with less education in both racial groups. However, the WIC effect for less educated whites was not statistically significant.

The relationship of WIC to preterm delivery (under 37 weeks gestation) is similar. There were large and significant reductions among the less educated, both whites and blacks. If the effects for all deliveries were contributed only by those directly served by the WIC program, among less

Table III-14

The Effect of WIC on Duration of Gestation

	% Gestation <33 weeks				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	2.01	2.36	1.25	5.70	3.80
Change/year[a]	-0.03**	-0.02	-0.03**	-0.01	-0.06
Difference between counties at mean versus zero level of WIC penetration	0.26***	0.11**	0.04**	-0.00	-0.05
Effect within county, 1980 penetration level versus zero penetration	-0.04	-0.19*	0.02	-0.07	0.06
Effect among WIC recipients, if effect contributed only by them[b]	-0.25	-0.77*	0.15	-0.16	0.22
Coefficient of autocorrelation	--	0.02	--	--	--
Level of significance of WIC effect accounting for autocorrelation	--	0.05	--	--	--
Number of counties	822	475	729	110	118

See notes at end of table. (continued)

Table III-14 (continued)

	% Gestation <37 weeks				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	6.59	7.67	4.91	13.77	10.66
Change/year[a]	-0.07	-0.08*	-0.03	-0.08	-0.09
Difference between counties at mean versus zero level of WIC penetration	**0.61*****	**0.33*****	**0.14*****	**0.45**	**-0.02**
Effect within county, 1980 penetration level versus zero penetration	-0.15*	-0.44***	0.01	-0.86*	-0.35
Effect among WIC recipients, if effect contributed only by them[b]	-0.92*	-1.79***	0.05	-2.04*	-1.25
Coefficient of autocorrelation	0.05	-0.05	--	0.02	--
Level of significance of WIC effect accounting for autocorrelation	0.09	0.02	--	0.03	--
Number of counties	822	475	729	110	118

See notes at end of table. (continued)

Table III-14 (continued)

	Mean gestation (weeks)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	39.06	39.14	39.27	38.08	38.39
Change/year[a]	0.002	0.01	-0.00	0.01	0.01
Difference between counties at mean versus zero level of WIC penetration	-0.09***	-0.06***	-0.05***	-0.00	-0.00
Effect within county, 1980 penetration level versus zero penetration	0.03*	0.05**	0.00	-0.00	0.02
Effect among WIC recipients, if effect contributed only by them[b]	0.20*	0.22**	0.03	-0.01	0.07
Coefficient of autocorrelation	0.03	-0.02	--	--	--
Level of significance of WIC effect accounting for autocorrelation	0.03	0.01	--	--	--
Number of counties	822	475	729	110	118

*p < 0.05.
**p < 0.01.
***p < 0.001.

[a]Unadjusted.

[b]Assuming county-wide effect contributed only by women directly served by WIC program.

educated whites there was a 23 percent reduction in preterm delivery (a reduction of 18 per 1,000 deliveries, from a base rate of 77 per 1,000, $p = 0.02$ after accounting for autocorrelation). Among less educated blacks, WIC enrollment was associated with about a 15 percent reduction (20.4 per 1,000 deliveries, with a base rate of 138 per 1,000, $p = 0.03$, after accounting for autocorrelation). The rate of preterm delivery was unrelated to WIC for the more educated blacks and whites.

Mean duration of gestation for blacks in both educational strata was more than a week shorter than for whites of comparable education. WIC penetration was associated with significantly longer gestation among less educated whites (an increase of 0.22 weeks, assuming the entire effect was among those served, $p = 0.01$ after accounting for autocorrelation). The WIC effect for the other three groups was statistically insignificant.

The results appear to be reasonably convincing and, given the pattern of stronger results among the less privileged, very unlikely to have been confounded by concurrent changes in health care.

6. Birthweight

The analysis results for birthweight are presented in Table III-15. The proportion of births with birthweight under 2500 g occurring in the study sample of 888 counties decreased at the rate of 1 birth per 1000 per year during the period 1972 to 1980. This change was occurring for births with birthweight between 1500 g and 2500 g, because the proportion of very low birthweights (<1500 g) did not decrease during this time period. The mean birthweight increased at the rate of 6.7 g per year in the study sample.

In the total population of births, the penetration of WIC was not significantly related to reduction in either the proportion of infants with birthweight under 1500 g or under 2500 g.

The increase in mean birthweight of 23 g associated with enrollment in the WIC program, while in the range hypothesized to be the likely contribution of the program, was not significant at the 0.05 level.

Among the subgroups of women defined by education and race, none of the relationships of WIC penetration with very low birthweight (<1.500 g) was statistically significant, but there was a pattern of a stronger relationship among those with less education.

There were marked disparities in the frequency of low birthweight (<2,500 g) by education and race, with a range of 46 per 1,000 among more educated whites to 139 per 1,000 among less educated blacks. However, WIC was not associated with a statistically significant reduction in low birthweight for any of the four subgroups. However, the reduction for both black groups approached significance and was noticeably higher than for whites.

Table III-15

The Effect of WIC on Birthweight

	% Birthweight <1500 grams				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	1.04	1.04	0.62	2.37	1.88
Change/year[a]	-0.003	0.01	0.001	0.02	0.01
Difference between counties at mean versus zero level of WIC penetration	0.11***	0.05**	0.02**	0.08	0.08
Effect within county, 1980 penetration level versus zero penetration	0.02	-0.03	-0.01	-0.10	0.02
Effect among WIC recipients, if effect contributed only by them[b]	0.11	-0.12	-0.10	-0.25	0.06
Coefficient of autocorrelation	--	--	--	--	--
Level of significance of WIC effect accounting for autocorrelation	--	--	--	--	--
Number of counties	888	475	730	110	118

See notes at end of table. (continued)

Table III-15 (continued)

	% Birthweight <2500 grams				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	6.84	7.68	4.57	13.91	10.59
Change/year[a]	-0.10***	-0.07***	-0.08***	-0.03	-0.15***
Difference between counties at mean versus zero level of WIC penetration	0.64***	0.37***	0.23***	0.31	0.41**
Effect within county, 1980 penetration level versus zero penetration	-0.07	-0.10	-0.06	-0.63*	-0.50
Effect among WIC recipients, if effect contributed only by them[b]	-0.43	-0.39	-0.43	-1.49*	-1.79
Coefficient of autocorrelation	--	--	--	0.05	0.00
Level of significance of WIC effect accounting for autocorrelation	--	--	--	0.11	0.07
Number of counties	888	475	730	110	118

See notes at end of table. (continued)

Table III-15 (continued)

	% Birthweight <2500 grams	
	Race	
	White	Black
	≤37 weeks gestation	37+ weeks gestation
Mean	40.58	3.25
Change/year[a]	-0.19	-0.08***
Difference between counties at mean versus zero level of WIC penetration	0.07	0.33***
Effect within county, 1980 penetration level versus zero penetration	0.66	-0.07
Effect among WIC recipients, if effect contributed only by them[b]	4.16	-0.46
Coefficient of autocorrelation	--	--
Level of significance of WIC effect accounting for autocorrelation	--	--
Number of counties	788	822

See notes at end of table. (continued)

Table III-15 (continued)

	Mean birthweight (grams)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	3,334.51	3,286	3,408	3,056	3,147
Change/year[a]	6.70***	1.54*	7.39***	1.04	6.04***
Difference between counties at mean versus zero level of WIC penetration	**-30.23*** **	**-21.02*** **	**-17.38*** **	**-11.40* **	**-9.03* **
Effect within county, 1980 penetration level versus zero penetration	3.54**	11.35***	4.95***	10.98*	9.41
Effect among WIC recipients, if effect contributed only by them[b]	22.71**	46.62***	43.71***	26.05*	33.55
Coefficient of autocorrelation	0.12	0.05	0.09	0.06	0.04
Level of significance of WIC effect accounting for autocorrelation	0.07	0.0001	0.02	0.10	0.13
Number of counties	888	475	730	110	118

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Unadjusted.

[b]Assuming county-wide effect contributed only by women directly served by WIC program.

There was a 352 g disparity in birthweight between the children of better educated whites and less educated blacks. The effects of race and education on birthweight appeared to be additive; there was about a 100-g greater birthweight in both races associated with more education. There was remarkably greater increase in birthweight over the course of the decade among children of better educated women (five to sixfold greater) than among those with less education. This important difference is consistent with some change in maternal behavior or care strongly correlated with education, such as reduction in cigarette smoking, and warrants further study.

Increase in mean birthweight associated with WIC benefits was observed in all four groups of births stratified by maternal education and race. However, it was only statistically significant for the two white subgroups. Among less educated whites, the birthweight increase associated with WIC was 47 g ($p<0.0001$), for more educated whites, 44 g ($p<0.02$).

The magnitude of estimated effects of the WIC program in all four of the subgroups are greater than that for the total population. The possible explanations are that, first, the subgroup analyses were limited only to singleton deliveries, while the results for the total population included all deliveries. Second, the subgroup analyses excluded racial groups other than blacks and whites, and those with unknown education while the totals did not. Further, the number of counties available in the subgroup analyses was smaller than for the analyses of the total population, and the populations studied were therefore not identical. Most important, two large States were excluded from the subgroup analyses because education was missing from their data files. As it happens, and it must be assumed this was a matter of chance, in these two States, with a combined total of 102 counties, there was only a weak relationship of WIC penetration with birthweight. Thus, the subgroup analyses were for a subset of States where effects were greater.

The results for mean birthweight, in conjunction with those for rate of low birthweight delivery, suggest a general shift upward in birthweight due to WIC, especially among whites, without reduction in the incidence of tiniest infants. Among blacks, there was a decrease of appreciable magnitude in the likelihood of low birthweight associated with WIC, as well as increased mean birthweight. However, both of these effects were not statistically significant.

The disparity in effect of WIC penetration on duration of gestation, and on change in birthweight, is confusing. Possibly the far smaller secular change in birthweight over the decade among the infants of the less educated is a clue: among these births, mean birthweight hardly changed over time, while rates of low birthweight and preterm delivery (at least among whites) went down appreciably. Thus, these results support the conclusion that there can be differential change in different indices describing birthweight: the entire distribution of birthweight may change with change in the population mean, but there may also be changes in the frequency of low birthweight, without a shift of the entire distribution

of birthweights. Some evidence for such differential effects of WIC benefits on birthweight and duration of gestation among women of different races, and with different levels of education, have been found in this study.

The hypothesis was that the effects on birthweight might be different before and at term, following the report of Kessel and Villar (1983) that the decline over the past decade in rates of low birthweight has been much greater at term than before. The WIC program might therefore be expected to have greater effect on the incidence of low birthweight at term than preterm. Therefore, the rate of birth under 2500 g was analyzed separately for those born prematurely and those born at term. This analysis, therefore, removes much of the effect of the WIC program on birthweight mediated by increased duration of gestation. Over the course of the decade, there was no significant decrease in the rate of low birthweight preterm, but a highly significant decrease in low birthweight at term. While the concurrent decreases in perinatal morbidity and mortality have been ascribed to high technology perinatal hospital care, this result strongly suggests that there have also been important changes going on during pregnancy, especially in conjunction with decreases in fetal mortality (see below).

WIC penetration was not significantly related to the rate of low birthweight among either preterm or term deliveries. However, the estimated changes were in the directions predicated: reduction in low birthweight at term, but not in rates of preterm low birthweight.

7. Fetal and Infant Mortality

The analysis results for fetal and infant mortality are presented in Table III-16. All indices of fetal and infant loss significantly decreased over the course of the decade. While, as expected, infant mortality was significantly higher in counties which had WIC programs, there was no significant excess fetal mortality associated with the likelihood of service by the WIC program.

The magnitude of lower mortality associated with WIC penetration was of the order of magnitude predicated at the onset of this study, but none of the analyses were significant. However, the effect of WIC on fetal mortality turned out to be significant when data from States without complete data were combined with the data set comprised of complete data.

The reductions in early and total neonatal mortality (0 to 6 days and 0 to 27 days, respectively) of about 2 per 1,000 births, were of appreciable magnitude, but neither was significant. The reduction in postneonatal mortality (28 to 364 days) was of low magnitude and was not statistically significant.

The relationship of WIC penetration to fetal mortality in the four States without penetration rates for all years is of importance (see Volume IV, Appendix III-D, Table D-4). This analysis included 1172 county-years of experience. (The main analysis was of 7371 county-years, so that this

Table III-16

The Effect of WIC on Fetal and Infant Mortality

	Fetal death rate at ≥28 weeks gestation (per 1000 births)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	6.21	5.75	4.95	8.05	7.96
Change/year[a]	-0.27***	-0.39***	-0.19***	-0.79***	-0.40**
Difference between counties at mean versus zero level of WIC penetration	0.11	0.29	0.11	-0.17	0.00
Effect within county, 1980 penetration level versus zero penetration	-0.31	-0.12	-0.30	-0.61	-0.74
Effect among WIC recipients, if effect contributed only by them[b]	-2.12	-0.53	-2.75	-1.44	-2.66
Coefficient of autocorrelation	0.05	--	--	--	--
Level of significance of WIC effect accounting for autocorrelation	0.25	--	--	--	--
Number of counties	819	437	665	105	111

See notes at end of table. (continued)

Table III-16 (continued)

	Early neonatal death rate 0 to 6 days (per 1000 births)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	9.13	9.33	6.66	14.26	12.04
Change/year[a]	-0.66***	-0.79***	-0.51***	-0.98***	-0.52***
Difference between counties at mean versus zero level of WIC penetration	0.47**	0.25	-0.05	0.69	-0.32
Effect within county, 1980 penetration level versus zero penetration	-0.30	-0.44	-0.62	-1.32	0.30
Effect among WIC recipients, if effect contributed only by them[b]	-1.89	-1.79	-5.22	-3.08	0.60
Coefficient of autocorrelation	--	--	0.02	--	--
Level of significance of WIC effect accounting for autocorrelation	--	--	0.23	--	--
Number of counties	582	306	445	83	85

See notes at end of table. (continued)

Table III-16 (continued)

	Neonatal death rate 0-27 days (per 1000 births)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	10.59	11.08	7.79	16.68	13.71
Change/year[a]	-0.69***	-0.83***	-0.53***	-1.13***	-0.56**
Difference between counties at mean versus zero level of WIC penetration	0.55***	0.25	-0.06	0.70	-0.19
Effect within county, 1980 penetration level versus zero penetration	-0.36	-0.56	-0.73*	-2.00	0.16
Effect among WIC recipients, if effect contributed only by them[b]	-2.29	-2.27	-6.15*	-4.66	0.55
Coefficient of autocorrelation	--	--	0.03	--	--
Level of significance of WIC effect accounting for autocorrelation	--	--	0.18	--	--
Number of counties	582	306	445	83	85

See notes at end of table. (continued)

Table III-16 (continued)

	Postneonatal death rate 28 to 364 days (per 1000 births)				
		Race			
		White		Black	
		Education (yrs)		Education (yrs)	
	Total	<12	12+	<12	12+
Mean (1972-1980)	3.77	5.55	2.60	10.52	4.94
Change/year[a]	-0.08**	-0.08	-0.03	-0.22	-0.15*
Difference between counties at mean versus zero level of WIC penetration	0.38***	0.14	-0.01	-0.08	0.15
Effect within county, 1980 penetration level versus zero penetration	-0.11	-0.07	-0.07	0.12	0.22
Effect among WIC recipients, if effect contributed only by them[b]	-0.69	-0.28	-0.36	0.29	0.75
Coefficient of autocorrelation	--	--	--	--	--
Level of significance of WIC effect accounting for autocorrelation	--	--	--	--	--
Number of counties	582	306	445	83	85

See notes at end of table. (continued)

Table III-16 (continued)

	Neonatal death rate 0 to 27 days (per 1000 births)		
	Birthweight (grams)		
	≤1500g	1501-2500g	≥2500g
Mean (1972-1980)	531.55	49.18	5.82
Change/year[a]	-14.24***	-4.26***	-0.30***
Difference between counties at mean versus zero level of WIC penetration	-3.73	0.72	0.26*
Effect within county, 1980 penetration level versus zero penetration	-17.95	-1.61	-0.16
Effect among WIC recipients, if effect contributed only by them[b]	-113.34	-10.13	-1.01
Coefficient of autocorrelation	--	--	--
Level of significance of WIC effect accounting for autocorrelation	--	--	--
Number of counties	292[c]	565	582

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a]Unadjusted.

[b]Assuming county-wide effect contributed only by women directly served by WIC program.

[c]Number of counties is small because a county had to have at least one birth within the birthweight category for each study year to be included in the analysis.

increased the study sample some 16 percent). For these four States, weighting results by the number of county-years available in each State and the mean State WIC penetration, the estimated reduction in fetal mortality was 4.6 per 1,000 among WIC recipients, if the entire effect was contributed by them. This large estimated effect, although statistically insignificant, is supplemental support for a conclusion that WIC benefits probably led to reduced fetal mortality.

The direction and magnitude of the results in the separate analysis of these four States required the development of an analytic scheme which could incorporate the results in these four States with those of States with complete data for all years. The following paragraphs describe how this analysis was done.

It is possible that there is an association between the availability of data on the WIC program in a State and the effectiveness of the WIC program. It was therefore prudent to evaluate whether the estimate of WIC effect was related to whether the data for the State were complete or not. Two analyses were directed to this goal: in the first, separate estimates were generated for States with complete data and for the four States with missing data (the full model); in the second, a single estimate of WIC effect was computed for all States (the reduced model). The reduced model can be formally considered a restricted or special case of the full model, and for this reason, there is an exact test available of the adequacy of the restriction which differentiates the two models. It is possible to test whether there is a significant departure from the assumption of a single estimate of the effect of the WIC program. Alternatively, this tests whether the parameters which specify the relationship of WIC penetration to outcome in the States with missing data significantly differ from that of the central analysis.

The regression analysis tests for the effects of WIC penetration on fetal mortality, with the effects of time and county controlled. Within each of the States with some years of data missing, the fetal mortality and penetration measures were transformed to adjust for variation with time and across county. The fetal mortality rates and penetration measures for the States with complete time series were also adjusted as one set for time and county effects. The results for the four States with incomplete time series and for the States with complete data were then combined in one simultaneous analysis of WIC penetration effects on fetal mortality. The test of whether or not a single estimate of WIC effect was appropriate is a test of the significance of adding to the analysis the interactions of WIC penetration with dummy variables specifying each of the four States with missing data. The tests for nonhomogeneity of effect, and the combined (reduced model) analysis are presented as Appendix III-H in Volume IV.

Inclusion of the States with missing data for some years resulted in an increase in the estimate of WIC penetration effects from -2.12 to -2.30 per 1,000, assuming that the effect arose entirely from change among those served by the WIC program. This estimate was significant at a level of probability $p = 0.036$. The test of whether a single estimate of WIC effect

was appropriate revealed no statistically significant departure from homogeneity of WIC effect for the four States with missing data. It is not possible to estimate and correct for autocorrelation when States with missing years of data are included in the analysis.

A level of reduction in fetal mortality was not predicated at the onset of the study because there was little or no prior data on effects of nutrition in pregnancy on fetal mortality. The magnitude of reduction in neonatal mortality associated with WIC was at the level predicated. If these results for neonatal mortality are stable (i.e., hold for as yet unstudied counties), they would be impressive, and would be consistent with important and very worthwhile program benefits.

The differences with maternal race and education in average fetal death rate over the decade of study are much smaller than for the other perinatal outcomes, and the improvement over the decade was greater for those with less, rather than more education, and for blacks rather than whites. The reductions associated with WIC penetration were greater among those with more education, but none of these relationships of WIC penetration to fetal mortality were significant. Given the large magnitude of the estimated reduction of fetal mortality associated with WIC benefits among all births, it is plausible that the effect of the WIC program may have been great enough so that it was one of the dominant contributing factors to the downward secular trends in the less educated and that adjustment for secular trend may have removed an appreciable part of the effect of the WIC program. Other analytic strategies, such as Linear Structural Equations Model (LISREL) or path analysis, or less satisfactorily, multivariate analysis with terms for the interaction of WIC penetration and time, could be used to attempt to not overadjust time trends.

Both the early neonatal (0 to 6 days) and neonatal (0 to 27 days) death rates of these indices fell dramatically over the decade; in general, the magnitude of decline was proportional to the mean rate. The pattern of results for the neonatal and early neonatal death rates were very similar. Thus, the average annual decline in neonatal mortality for more educated whites of 0.53 per 1,000 was equivalent to 6.8 percent of the mean rate of 7.79 per 1,000; the decline of 1.13 deaths per 1,000 livebirths among less educated blacks was also a 6.8 percent yearly decline, based on a mean rate of 16.6 per thousand livebirths. The group that had least change was more educated blacks, with a decline of 4.1 percent per year.

The magnitude of decline in neonatal mortality associated with WIC was substantial for all but more educated blacks, but not statistically significant for any subgroup. This was true for both the early neonatal and neonatal death rates.

There was greater variability with maternal race and education in postneonatal mortality than for death in the first month of life or fetal death: children of less educated blacks were four times more likely to die between the second and eleventh months of life than those of better educated whites. The rates for better educated blacks and less educated whites

were intermediate, and nearly identical. Reductions over time were not great, and differences between high penetration and low pentration counties were not significantly different (i.e., counties with high average penetration did not have significantly worse rates than counties with low average WIC penetration). WIC penetration was only minimally related to postneonatal mortality, and none of the relationships were close to significance.

It was of interest to determine whether changes in mortality differed at different birthweights; in other words, was change in mortality mediated by change in birthweight, or was it over and above change in birthweight? The results suggest that within each of the three birthweight strata (≤1,500 g, 1,501-2,500 g, and >2,500 g) there was nearly equivalent reduction in mortality associated with WIC receipt of about 20 percent, but none of these reductions was near statistical significance.

These results, while only statistically significant for the relationship of WIC program penetration to fetal mortality, if stable (i.e., if they are similiar in other states), are consistent with the major benefits from WIC participation on perinatal mortality before and around the time of birth, but not on infant mortality later in the first year of life. Postneonatal mortality is considered to be sensitive to both social circumstances and to traditional preventive and therapeutic health care, and neonatal mortality is considered to be sensitive to intensive perinatal services. On the other hand, fetal mortality is usually considered relatively insensitive to health care inputs. Thus, these results are consistent with the WIC program functioning as much, or more, through improving the mother's physiological status during pregnancy as through changes in accessibility to and use of health services. This interpretation is consistent with the significant improvements in duration of gestation and birthweight associated with the WIC program, and is also consistent with the interpretation that associations of perinatal outcome and WIC penetration were not confounded by other health care inputs.

F. DISCUSSION

1. Relationship of WIC Penetration to Health Care

There was a strong and highly significant relationship between WIC program penetration and adequate numbers of visits for prenatal care, and a strong and significant relationship with the likelihood of first trimester registration for prenatal care.

Decreases in the rate of inadequate prenatal care associated with WIC were large. An average of 63 women per 1,000 were estimated to have inadequate prenatal care in the total study population; if the entire effect of the program was contributed by WIC recipients, the rate among them was reduced by 50 per 1,000, an 80 percent reduction ($p < 0.001$). The estimated effects in subgroups of women, based on race and education, were less strong than in the overall population, but consistent with the greatest change among those at greatest need with considerably greater effects among less educated women.

Assuming effects were due only to change among those who were enrolled in the WIC program, the estimated increase in first trimester registration for prenatal care was 41 per 1,000 ($p = 0.02$ after adjusting for autocorrelation). The estimated increase among black women with fewer than 12 years of education was 67 per 1,000 ($p = 0.003$ after adjusting for autocorrelation). There was no significant increase for the remaining three groups.

There is some circularity of the relationship between the penetration index and the outcomes that are correlated with duration of gestation. Because the calculation of WIC penetration was based on prevalence and not incidence, if a woman registered early or had longer duration of gestation, the penetration index would rise, leading to a partially confounded relationship. On the other hand, there is no confounding for reduction in inadequate prenatal care, and this was highly significant and of considerable magnitude. The estimated change in penetration with increased gestation is about a 0.27 percent increase in penetration for 1 day of increased gestation, or 1.92 percent for 1 week of increased gestation (see Volume IV, Appendix III-G). This change is of small magnitude and is consistent with a conclusion that the confounding accounts for only a very small part of the observed relationships.

While the confounding caused by longer duration of care leading to higher WIC penetration is probably of small magnitude, confounding by health care is a real possiblity. If the WIC program promotes better health care, benefits might be mediated by this better care. However, if WIC penetration is associated with, not a cause of, better health care, then health care may be the operative, causal factor, and thus confound the relationship with WIC. For several reasons this is probably not the case. First, the nature of the results speaks against this conclusion. Medical interventions are likely to lower infant mortality, especially neonatal mortality and, to a lesser degree, fetal mortality. On the other hand, duration of gestation and birthweight have been thought to be fixed and relatively unresponsive to health care inputs, but rather reflections of maternal physiology (nutritional status, weight, height), behavior (smoking, alcohol, diet, workload, exercise), and inheritance (race, and other factors). Thus, WIC penetration was significantly related to outcomes less likely to be mediated by health care and more likely to reflect changes in maternal physiological status. Moreover, the lagged analysis was inconsistent with a confounded relationship. Clearly, the findings would be more secure if penetration were based on incidence (and therefore independent of duration of gestation) rather than on prevalence (a function of both incidence and duration of service and therefore confounded to an extent with duration of gestation) but the estimates of the magnitude of this confounding suggest minimal effect on the predicated relationship between the WIC program and perinatal outcome.

The results are strong evidence that the WIC program is an inducement to and a vehicle for achieving more advantageous prenatal care.

For reasons described above, these improvements in health care (which probably are correlated with many other ways that health care may have been improved, but for which no data are available) are unlikely to have been the exclusive mediators for the improved perinatal outcome associated with WIC. There is strong internal evidence from the study that the nutritional benefit was probably the major determinant of the observed changes.

2. Relationship of WIC to Duration of Gestation and Birthweight

Duration of gestation and birthweight were affected significantly by the WIC program. There was a significant increase in mean duration of gestation of 1.4 days ($p = 0.03$ after adjusting for autocorrelation). The pattern of results among subgroups of births stratified by maternal race and education supports the conclusion that benefits did occur. Among the less educated, both whites and blacks, the reductions in preterm delivery were about double the rate for all births and were statistically significant. Among less educated whites, the increase in mean gestation and the decrease in very preterm (under 33 weeks gestation) delivery were both significant.

Changes in mean birthweight were associated with the WIC program. The estimated increases in mean birthweight for WIC recipients, depending on the births studied, ranged from 23 to 47 g. In the total population, the estimate was 23 g ($p = 0.07$ after adjusting for autocorrelation), and in the subgroups defined by maternal race and education, estimates ranged from 26 g (less educated blacks, $p = 0.10$ after adjusting for autocorrelation) to 47 g (less educated whites, $p < 0.001$). Some sense of the importance of WIC benefits can be gained by comparing the magnitude of the changes associated with WIC with the secular change over the 9-year period of the study. For less educated blacks there was only a 10.4-g increase in mean birthweight over the 9 years, and for less educated whites there was a 15.4-g increase. Thus, the effect of WIC benefits was two to three times as great as the background change occurring for the infants of these less educated women.

Among those with more education, the secular change was considerably greater, suggesting that with fewer economic constraints or possibly because of better health behavior such as reduced cigarette smoking, infants of more-educated women had far greater increase in birthweight over the decade than infants of less educated women. More-educated women may have reduced cigarette smoking or improved their diets. For whatever reason, infants of mothers with more education experienced great increases in birthweight over this decade, and the response to WIC was thus relatively much more important among those with less education. It was possible that the more educated might use WIC benefits more efficiently, even though they were likely to have been at less need. The results of this study suggest that both groups profited from WIC benefits, but that improvement for the less educated was more important, since change from other factors was so much less.

It is noted that the significant reduction in preterm births (18 per 1000) associated with WIC benefits among less educated whites was not reflected in a significant reduction in the proportion of births with low birthweight for this group. Because relatively few births are preterm or low birthweight, the sensitivity or power of these data to detect WIC effects of the order of 10 to 20 per 1000 births as statistically significant is lower than desired. In addition, the proportion of low birthweights can be affected by full term as well as preterm births.

The less-educated black WIC recipients had a significant reduction of 20 fewer preterm births per 1000 births. The decrease in the rate of birthweight under 2500 g for this group, although not significant at the 0.05 level, was of appreciable magnitude, of 15 fewer lower birthweights per 1000 births ($p = 0.11$).

These results are considered consistent with birthweight increases mediated both by decreases in preterm delivery and by accelerated fetal growth; the latter not being limited to those of lowest birthweight, but among births over 2500 g as well.

Possibly, some confounding factors might have led to this pattern of longer duration of gestation and increased birthweight associated with WIC penetration. The only securely identified confounding factor is that the penetration index is systematically correlated with duration of gestation. On the other hand, the calculated magnitude of this confounding is very small (see Volume IV, Appendix III-G). Another source of confounding could be change due to other health services that are correlated with WIC penetration. This seems an unlikely explanation for changes in duration of gestation, birthweight, and fetal mortality because these are outcomes which are relatively unresponsive to changes in traditional prenatal care. In addition, change should be as great or greater among the better educated than among the less well educated. Most innovations in health care in an area would be used earlier and with greater intensity by the more educated and affluent. A pattern of greater effect among the less educated and less affluent is inconsistent with such confounding. The extent of programs aimed at the poor, such as the Maternal and Infant Care projects, is very unlikely to be great enough in magnitude to explain the relationship with WIC penetration, even if correlated with WIC penetration. If the effects of the WIC program are confounded by other health services or mediated by health service, then effects on mortality, particularly neonatal mortality, should be far greater than effects on duration of gestation, birthweight, or fetal mortality, which historically have been far more resistant to manipulations in health care than has been infant mortality, and the better educated should be profiting as much, or more, than the lesser educated. This is clearly not the case.

3. Relationship of WIC to Fetal and Infant Mortality

The results of these analyses suggest that reductions in infant mortality associated with WIC benefits are of the magnitude which had initially been predicated, and reductions in fetal mortality are significant by traditional statistical conventions.

The estimated reduction due to WIC of about one-third in fetal mortality is consistent with important program effects. Overall reduction in fetal mortality over the decade was of about the same magnitude as that associated with the receipt of WIC benefits; fetal mortality has fallen less than neonatal mortality during this period, and the relative contribution of WIC may have been much greater than other factors. This important possible contribution of the WIC program, relative to other factors, again suggests that if these effects are real and stable, they would not have been mediated exclusively by change in the quality of health care (which probably has been responsible for most of the dramatic fall in neonatal mortality), but rather in factors that are relatively less amenable to medical care inputs and more likely relate to nutrition and the general well being of the mother.

While not statistically significant, the magnitudes of decrease in neonatal death rates associated with WIC benefits among all births (2.3 per 1,000), among more and less educated whites (6.2 per 1,000, and 2.3 per 1,000, respectively), and less educated blacks (4.7 per 1,000) are large and consistent with important program benefits.

G. CONCLUSIONS

All studies of the effect of the WIC program (with a few exceptions) depend on comparisons that can never lead to the security of inference of the most sophisticated experimental research designs, such as randomized trials. Thus, the weaknesses of this historical design must be weighed against the weakness of other alternate or complementary studies, and the special strengths of this approach also should contribute to final judgment of these results.

These analyses were unlike any others used to evaluate the WIC program, either in method or scope. The credibility and meaning of the results depend on several factors: whether the results are consistent with those of other research, done with different strategies and among different populations, but aiming to assess some of the same issues; whether they are likely to have been affected by WIC program inputs; and whether they are sufficiently unlikely to have arisen by chance. It is as important that the pattern of these results is sensible and leads to some logical understanding of the program and its social and medical significance as whether results met the conventions of statistical significance.

There is now adequate justification to extend the analyses to an even larger number of States, since in a number of instances the WIC effects, while attaining their predicted magnitude, were not statistically significant. It seems clear that the analyses should be extended to other States where WIC penetration can be calculated, but which were not included in this initial study because the birth and death certificate files were not in a form in which they could be included with relative efficiency. NCHS aims to have linked birth and death certificates from all States in the very near future. If their files extend back to the early seventies, subsequent analysis will be greatly facilitated. It will be impossible to

include in any subsequent analyses those States where numbers of women who receive WIC benefits are unavailable by county.

The model used to estimate WIC effects in this study is a relatively simple model. Subsequent research could modify this model in two major respects. First, the model assumes that the effect of WIC penetration is the same for all counties and all time periods. This assumption is reflected in the single regression parameter associated with WIC penetration. It could be that the effect of WIC varies over counties or over time; that is, there is an interaction of WIC with time or county. Further analysis could test these assumptions. Second, it assumes that the effect of WIC penetration is linear. It could be that the effect of WIC penetration is nonlinear in that the marginal effect of WIC at high penetration levels is less than its effect at lower penetration levels. This could easily be tested by including a quadratic term for WIC in the regression model. Again, further analyses could test these assumptions.

Another limitation is that $\hat{\beta}$ could be a downward-biased estimate of the effects of WIC penetration since the numerator and denominator of the WIC penetration index are both estimates with unknown error characteristics. Finally, a different approach would be to apply Linear Structural Equation Models (LISREL). With LISREL, for each year, path coefficients could be computed between penetration and outcome, net of prior penetration and outcome. It is possible to test whether these coefficients changed over time as the program has grown. This approach takes autocorrelation into account.

There are several additional analyses which had been intended, but which were beyond the resources available. They include the judgment of whether WIC was more effective among younger women and women of lower parity (which was posited from past research).

When planning and designing this study, after having judged that it was necessary to estimate the effect of the WIC program over its entire history, it was frustrating that it was not feasible to link records of individual receipt of WIC to perinatal income. While this strategy was appealing and would have added several important strengths to the study, it is important to reflect on the special value of the historical level analyses that were done. Recognizing that cost and other factors stood in the way of conducting a large national, matched-record study of WIC participant files and linked birth/death certificate files, the historical approach was an excellent substitute. It provided an opportunity to measure the impact of the WIC program nationwide over a significant time period and with a sufficiently large sample to estimate WIC effects on relatively rare events, such as fetal mortality. Focusing on the county as the unit of analysis is very suitable for the analysis of programs, in that programs such as WIC are designed to solve public health problems. The historical approach permitted not only inferences at the national level, and for subsets of the population defined by education and race across time, it also permitted analyses for groups of counties characterized by type of area, population, and program. All of these analyses are also possible

with a linked record file at the individual level. In addition, for the same total number of individual records, the statistical power of the analyses, and hence sensitivity to small effects, should be greater in a study of individuals. However, it should also be recognized that the historical approach avoids some of the major problems of matched-record studies at the individual level, namely the biasing effects of failing to match records that should be matched and of matching errors in records that are matched.

The estimated magnitudes of benefit associated with the WIC program are large and even though some were not statistically significant, they are consistent with the better past analyses of the effect of WIC on perinatal outcome even though this study took a very different approach both in design and analysis. Most past studies were too small to generate meaningful estimates of the effects of the program on perinatal mortality. This study also was affected on occasion by relatively few data units, even though it started with approximately 11 million births. However, the unit of analysis was the county-year, and for some analyses, especially among the race and education subgroups, the number of such units was rather small for the magnitude of effects to be detected.

The effective sample size was somewhat less than the total county-years of data for most of the analyses. The year-to-year correlation in the outcome variables reduces the effective sample size in essentially the same manner as in a cluster sample. If the autocorrelation is unity, the effective sample size is the number of counties, regardless of the number of years of data available. If the autocorrelation is zero, the effective sample size is the number of county-years of data. The autocorrelations observed ~~in~~ this study for the major outcome variables (gestation, birthweight, fetal and infant mortality) were in the neighborhood of 0.05, which reduces the effective sample size by 30 percent. The estimated autocorrelation for mean birthweight for the total sample was 0.12 which cut the effective sample for estimating the WIC effect approximately in half. Thus, although the county-years of data available were about 9,000, the effective sample size was only about 4,500 in an analysis in which the estimated increase in mean birthweight for WIC recipients of 23 g represented just 0.6 of a percent of the overall mean birthweight. The power of an effective sample size of 4,500 to detect as statistically significant a birthweight difference this small is less than 50 percent.

The magnitudes of estimated WIC effects in this study for improved prenatal care, increased duration of pregnancy, increased birthweight, and decreased fetal (and, possibly neonatal) mortality for all WIC recipients and for subgroups of WIC recipients were all meaningful from a program standpoint. Therefore, it would be useful in subsequent research and important in terms of statistical efficiency to extend the analysis over more years and for all States where it is feasible, in spite of the incrementally higher costs of adding additional years and States, and to apply alternative and more intensive analytic approaches to these data.

The analytic model assumes that the county and time parameters capture the major influences (e.g., health care expenditures and socioeconomic

status of county) on the outcome (dependent) variable associated with counties and with time. The WIC penetration parameter (β) reflects the influence of WIC on the dependent variable above and beyond the general trends in that variable across counties and time. In order to draw any causal inferences on the basis of the estimated WIC penetration parameter, it is necessary to assume that the county and time parameters account for all the sources of influence on the dependent variable that are potentially confounded with WIC penetration. One can never be sure of this, although intuitively it would seem that the county and time parameters do a good job in adjusting the WIC penetration parameter.

Since confounding cannot be rejected from the analyses in this report (given the level of error and incomplete ascertainment of confounding factors) any significant evidence of confounding would imply that presumed effects of the WIC program should be interpreted with caution. Confounding by health care is probably unlikely; the pattern of the relationships estimated from WIC penetration in the study appear to be much more likely a function of the program. The analyses among the four subgroups of births defined by mothers' education and race have helped to judge the likelihood of confounding. Most countywide confounders, certainly those relating to improved perinatal services, should affect the more privileged as much or more than the less privileged, given the way services are distributed and used in our society. Thus, if the results are due to confounding, effects ought to be stronger among the better educated and among whites rather than blacks. In general, this was not the case.

In addition, confounding by improved perinatal services (fetal monitoring, operative obstetrics, neonatal intensive care, etc.) should have had almost no effect on birthweight or duration of gestation, only minimal effect on fetal mortality (other than for the relatively small component of fetal mortality contributed by intrapartum death), but large effects on neonatal and possibly postneonatal mortality. Health care, both preventive and therapeutic, can strongly affect these latter indices, but is at best weakly related to the former ones. The balance and kinds of estimated effects of the WIC program can thus help in the judgment of whether confounding was likely.

This study has been exploratory and perhaps pathfinding. The historical design, while in some ways flawed, was the only one available to provide nationwide estimates of WIC program effects over its duration. It would have been better to have had results from larger numbers of counties and for more years, with potentially greater statistically significance. It would also have been preferable to base the penetration index on incidence of WIC participation rather than prevalence. Nevertheless, the magnitude of the effects observed, though variable, and their strong, consistently favorable direction and coherence with WIC program goals allows some assurance in judging that the program has been successful in improving use of prenatal care and outcomes of pregnancy.

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Appendix II-D: Bibliography

II-D-1. Studies reviewed:

Argeanas, S., and I. Harrill. 1979. "Nutrient intake of lactating women participating in the Colorado WIC Program." Nutrition Reports International 20(6):805-810.

Bailey, L. B., B. O'Farrell-Ray, C. S. Mahan, and D. Dimperio. 1983. "Vitamin B6, iron, and folacin status of pregnant women." Nutrition Research 3:783-793.

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II-C-5. California Department of Health Services, Community Health Services Division. 1982. "Retrospective Study of the Special Supplemental Food Program for Women, Infants, and Children (WIC)." Unpublished report. Maternal and Child Health Branch, Sacramento, California.

This extensive report was primarily a description of participants in the program and of administrative issues, such as proportion lost to followup. Some outcome data were presented but were limited by the relatively few births available and the large number of women for whom the outcome of pregnancy was unknown. The proportion of infants with birthweight under 2,500 grams was related to trimester of entry into the WIC program. For those with first trimester of entry into WIC the rate was 3 percent; in the second trimester, 3.8 percent; and in the third trimester, 7.2 percent. The numbers of women in each group were not given. Statewide rates were 5.8 percent, 5.2 percent, and 5.5 percent, respectively.

Table II-C-4

WIC Teenage Pregnancy Outcome Project, Montana, 1978 to September 1981

(Birthweight (g) by WIC status and race; infants of mothers under 18 years of age)

	WIC	Non-WIC	Difference
Nonwhite[a]	3,430±340 (69)	3,323±391 (233)	107*
White	3,232±1673 (162)	3,121±768 (1,050)	111

*$p < 0.05$.
( ) = n.

[a]Predominantly American Indian.

II-C-4. Montana Department of Health and Environmental Sciences. 1982. "Executive Summary, WIC teenage pregnancy outcome project." Report submitted to the U.S. Department of Agriculture.

This was a study of the birthweights of infants of teenage mothers in the State of Montana. Four groups were compared: WIC recipients receiving a special modular educational package, WIC recipients from the same area before the educational package was instituted, those from other WIC programs without the modular educational package, and teenage mothers not enrolled in WIC. No differences were associated with the use of the modular educational package compared to other WIC participants. The results comparing WIC and non-WIC groups are uncertain, given the highly variable standard deviations of birthweights across group. In addition, comparisons in the report are confusing: outcomes for whites and nonwhites are contrasted, stratified by whether or not they had been enrolled in the WIC program. The more logical comparison would be between those enrolled in WIC and others, stratified by race (see Table II-C-4 below). The report stated that no significant differences were found when 18- and 19-year-olds were included, and therefore the analyses were limited to those 17 years of age and under. It would be helpful to know the outcome for the 18- and 19-year-olds.

The difference in birthweight associated with WIC enrollment was approximately the same in the two racial groups and, given their much lower standard deviations, significant among nonwhites. Without further information on the comparability of the WIC and non-WIC groups, other than race and age, it is difficult to draw conclusions from this study, particularly given the very large standard deviation for birthweight among whites. Errors in keypunching or other procedures are possible, and these figures should be verified.

Data were also presented on numbers of visits during pregnancy and frequency of complications, which did not differ given enrollment in WIC.

II-C-1. George, Nancy Noble. 1982. "Prepregnancy weights, weight gains, and other factors related to birthweights of infants born to overweight women." Dissertation submitted in partial fulfillment of the requirement for the Degree of Master of Education. Graduate College of Bowling Green State University.

This research related maternal weight at conception and weight gain during pregnancy to birthweight among 86 WIC participants and 57 private patients from the practice of one Toledo obstetrician. No data were presented on the racial, social, demographic, or health status of either group. Little inference can be drawn about effectiveness of the WIC program from the data presented.

II-C-2. Massachusetts Executive Office of Human Services, Department of Public Health. 1983. "1983 Massachusetts Nutrition Survey Executive Summary." Division of Family Health Services, Boston, Massachusetts.

This survey of 1,429 low-income children between the ages of 6 months and 6 years assessed height, weight, and hematologic status abstracted from clinic records. In the report, only one datum related the effect of the WIC program on health or nutritional status: of 900 children who met the WIC income eligibility criterion, there were 412 WIC participants, 22.9 percent of whom had at least one nutritional abnormality (low height for age, low weight for height, or anemia). About 15 percent of the residual income eligible children had at least one measure of undernutrition. No data were presented on whether these children had been enrolled in the WIC program in the past, nor was there any assessment of the comparability of the two groups, other than on family income.

II-C-3. Georgia Office of Nutrition, Department of Human Resources. 1982. "WIC/Nutrition Survey." Unpublished report.

A two-page outline of a study of participants in one WIC program in Georgia during fiscal year 1980 was available. Indices at enrollment were compared with values after intervention. Among 450 infants who had been defined as iron deficient, 46 percent had increased iron levels on remeasurement, 7 percent remained the same, and 10 percent had lower levels. These results cannot be interpreted as only due to the program, since they were most likely due, in part, to regression to the mean. The same limitation is true for the other outcome presented, obesity in childhood. Some 330 infants were identified as initially obese; on followup (the duration of treatment is not specified), 24 percent had decreased weight, 17 percent remained the same, 6 percent had fluctuating weight, and 6 percent had increased weight.

Appendix II-C: Studies received since the preparation of the initial report (January 1984)

Table II-B-12

Thenen (1982)

Population studied	None
Assignment method/ research design	Two examples of each WIC food in Massachusetts WIC package and four aliquots of each example analyzed.
Study group	
Number	None
Treatment	--
Control group	
Number	None
Treatment	--
Results	Mean folacin contents of WIC foods (μg/100 g)

Milks	3.6 ± 0.2	6.6 ± 1.7
Cheeses	3.2 ± 1.8	10.1 ± 0.7
Eggs	27.0 ± 2.4	46.6 ± 6.2
Cereals	1.3 ± 0.6	1,340.0 ± 309
Juices	0.12 ± 0.04	21.3 ± 1.0
Legumes	6.6 ± 0.6	87.0 ± 6.0

Comment
- No between or within sample reliability testing.

± = S.E.

II-B-12. Thenen, S. W. 1982. "Folacin content of supplemental foods for pregnancy." J. Amer. Dietetic Assoc. 80:237-241.

Thenen (1982) analyzed the folacin content provided by WIC food packages in Massachusetts to pregnant and lactating women. Two examples of each food were purchased. Each sample was analyzed in the prepared state (e.g., cooked, if usually eaten cooked) by four separate extracts, using lactobacillus casei as the assay microorganism. Folacin content varied for foods within food groups. For the cereals tested, the folacin content ranged from 1.3 micrograms per 100 grams (μg/100 g) for cooked Quick Cream of Wheat to 1,340 μg/100 g of Product 19 (which is fortified with folacin). Juices sampled ranged from 0.12 μg/100 g for apple juice to 21.3 μg/100 g for fresh orange juice. The folacin content for milks ranged from 3.6 μg/100 g for one sample of reconstituted nonfat dry milk to 6.6 μg/100 g for one sample of skim milk. Cheeses ranged from 3.2 μg/100 g to 10.1 μg/100 g.

Nutrient densities and the index of nutritional quality (INQ) for folacin were calculated. Nutrient density (micrograms of folacin per 1,000 kilocalories) was highest for Product 19 (3,170 μg/1,000 kcal) and lowest for Cream of Wheat (3.3 μg/1,000 kcal). Milks ranged from 43 μg/1,000 kcal for evaporated milk to 177 μg/1,000 kcal for skim milk. The nutrient density ranged from 5.1 μg/1,000 kcal for apple juice to 449 μg/1,000 kcal for reconstituted frozen orange juice.

The index of nutritional quality (INQ) is the nutrient density divided by 200 μg/1,000 kcal (based on RDA's). INQ's of $\geq$1.0 and $\geq$1.7 for lactating and pregnant women, respectively, were considered good folacin sources. The INQ was lowest for apple juice and Cream of Wheat (<0.1) and for split green peas, Kix cereal, and all cheeses (0.1). The INQ was highest for Product 19 (15.9), Total (14.4), and Concentrate (10.6) cereals.

Contributions of WIC foods to a total daily intake for pregnant and lactating women were calculated using the foods within each food group that were highest in folacin and those that were lowest and using amounts allocated monthly by the WIC program. The daily contribution of the foods covered vary from 50 to 554 micrograms of folacin and from 802 to 808 calories for high- and low-folacin foods, respectively.

Reliabilities for between food and within food analyses were not reported.

Table II-B-11

Slonim et al. (1981)

Population studied	Cherokee Indians--Eastern Band, North Carolina, 1978
Assignment method/ research design	Purposive sample of 10% of all participant households. Interviews and 24-hour dietary recalls. Participant observation of household. Data also gathered from 7 key informants and 5 professionals in WIC program.
Study group	
Number	50 WIC households
Treatment	(20 women participating in WIC); (30 mothers of infants and/or children participating in WIC)
Control group	
Number	None
Treatment	--
Results	

Use of WIC foods by household members

Household members	Number of household members	Time of meal: Morning	Noon	Evening
		% of household members		
WIC recipients:				
Women	20	75	65	70
Infants	19	95	74	89
Children	40	85	55	100
	Number of households			
Others:				
Children >5	24	42	5	52
Adults plus children	50	58	26	82

Infant feeding practices

	N	%
Reasons for breastfeeding		
Personal preference	25	52
Infant health	25	33
Total breastfeeding	38	66
Reasons for not breastfeeding		
Medical/work	13	50
Total not breastfeeding	38	44

Comment

- No information on amount nor type of nutrition education nor duration of WIC participation.

II-B-11. Slonim, A. B., K. M. Kolasa, and M. A. Baso. 1981. "The cultural appropriateness of the WIC program in Cherokee, North Carolina." J. Amer. Dietetic Assoc. 79:164-168.

Slonim et al. (1981) assessed infant feeding practices, meal patterns, attitudes toward the WIC program and WIC foods, and the distribution of WIC foods among 50 purposively selected WIC participant households of the Eastern band of Cherokee Indians over an 8-week period in 1978. Respondents included 20 women who were receiving WIC benefits, pregnant, or postpartum (whether or not lactating); 30 mothers of children receiving WIC benefits; and 7 key informants. Twenty-four hour dietary recalls, recorded for one WIC participant per household, and participant observation of household food use, were performed. These data were supplemented by interviews with five WIC professionals.

WIC foods were found to be used widely within Cherokee households. Sharing of WIC foods was common. The women were asked in the 24-hour dietary recall and interview to report usage of WIC foods at various times of the day. They reported that among households with non-WIC members, 58, 26, and 82 percent of household members consumed WIC foods (e.g., milk, cheese, and eggs) at the morning, noon, and evening meals, respectively. About 58 percent of the women reported that the receipt of WIC foods was responsible for increased consumption of WIC foods, as well as of food in general.

A high percentage of WIC women (66 percent) reported breastfeeding their youngest child. About 52 percent gave as the primary reason personal preference and one-third because it was healthier for the baby.

The sample was small, and there was no control group. In addition, the amount or type of nutrition education was not specified, nor the duration of WIC benefits.

Table II-B-10

Rye et al. (1978b)

Population studied	Subsample of pregnant WIC clients, Pima County, Arizona, 1976-77 (see Rye et al., 1978a). Subgroup with anemia or other pregnancy risk.
Assignment method/ research design	Retrospective review of anemia pre- and posteducational intervention, from clinic records. Review of birth records.
Study group	
Number	38
Treatment	With anemia
Number	157
Treatment	With high risk pregnancy WIC + objective-based education intervention.
Control group	
Number	None
Treatment	--

Results

Number of objectives met	% with increase in hemoglobin/hematocrit among anemic women
0	33 (9)
1+	72 (29)
2+	72 (29)
3+	76 (25)
4+	72 (19)
5	100 (1)

Number of objectives met	Birthweight <2,500 g (%)
0	5.7 (35)
1+	4.9 (122)
2+	3.6 (110)
3+	4.0 (101)
4+	3.9 (77)

Duration of WIC participation (months)	Average number of objectives met/women
1-3	2.1 (94)
4-6	3.5 (60)
7-9	5.7 (3)

Comment

- Small sample size. Intervention methods unclear. No controls. Number of objectives met confounded by duration of gestation.

( ) = n.

II-B-10. Rye, J., M. White, and M. Majchrzak. 1978b. "Does objective-based health education effect positive changes in the health status of WIC program clients? A report of preliminary findings in Pima County, Arizona." Unpublished report. Tucson, Arizona.

Rye et al. (1978b) reported preliminary results of an educational intervention program on cognitive gains and other educational and health status outcomes. Pregnancy outcome was related to whether educational objectives were met. In a sample of 38 WIC women with anemia, followed for 6 months, the proportion of women with improved hemoglobin levels increased with the number of objectives met. Intervention methods were unclear and the criteria for meeting objectives unspecified.

The percentage of low-birthweight infants born to 157 pregnant women receiving WIC benefits was related to the number of objectives met and the length of time in the WIC program. The percent of low birthweight infants was lower among women who met more objectives. Women met more objectives if enrolled in the program for longer time periods.

Sample sizes were small and educational intervention methods were not specified. There was no control group. The relationship of the number of objectives met and outcome was confounded by duration of gestation, and the comparability of those who met more objectives with the less successful is unknown.

Table II-B-9

Martinez and Nalenzienski (1979, 1981); Martinez and Stahle (1982)

Population studied	Mothers of 6 month old infants. Stratified sample from Market Development Corp. list of U.S. births, excluding births not considered to be public information, 1977-80 (control data only available to 1979).
Assignment method/ research design	Retrospective study of incidence and duration of breast-feeding. WIC participation identified in questionnaire.
Study group	
Number	1977: 1,729 1978: 3,504 1979: 4,352 1980: 6,165
Treatment	Maternal pre- and/or postnatal WIC participation.
Control group	
Number	1977: 17,715 1978: 22,422 1979: 22,220
Treatment	No maternal WIC participation during or after last pregnancy.
Results	

% Breastfeeding

Age of child (months)	1977 WIC	1977 Control	1978 WIC	1978 Control	1979 WIC	1979 Control	1980 WIC	1980 Control
In hospital	33.6	44.7***	34.5	46.6***	37.0	51.0***	40.0	NA
2	22.5	32.9***	22.9	34.9***	24.4	NA	28.5	NA
3-4	15.8	25.6***	15.9	26.8***	17.8	NA	20.2	NA
5-6	12.5	19.4**	11.2	20.5***	12.2	23.0***	14.4	NA

Mean annual percentage increase in rate of breastfeeding

Age of child (months)	WIC[a]	Control
In hospital	2.13	3.15[b]
2	2.00	2.00[c]
3-4	1.47	1.20[c]
5-6	1.90	1.80[b]

Comment
- Response rate ranged from 54-62%. Data for 14.3-57.1% of respondents analyzed.

**$p < 0.01$.
***$p < 0.001$.
NA = Not available.
[a] 1977-1980.
[b] 1977-1979.
[c] 1977-1978.

II-B-9. Martinez, G. A., and J. P. Nalenzienski. 1979. "The recent trend in breastfeeding." Pediatrics 64(5):686-692.

Martinez, G. A., and J. P. Nalenzienski. 1981. "1980 update: The recent trend in breastfeeding." Pediatrics 67(2):260-263.

Martinez, G. A., and D. A. Stahle. 1982. "The recent trend in milk feeding among WIC infants." Amer. J. Public Health 72(1):68-71.

Martinez and Nalenzienski (1979, 1981) and Martinez and Stahle (1982) studied infant feeding practices from 1977 to 1980 in the Ross Laboratories quarterly survey. Since 1976, Ross Laboratories has assessed feeding patterns of a stratified sample of 6-month-old infants from the Market Development Corporation list of U.S. births. This list includes approximately 70 percent of births in the United States, but excludes illegitimate and multiple births and infant deaths.

Mothers are asked, "With your youngest child, have you ever participated in the supplemental food program called WIC (Women, Infants, and Children), which provides iron-fortified formula or coupons/vouchers for the purchase of infant formula?" The wording may thus imply the exclusion of breastfeeding WIC participants and might reduce the association of WIC with breastfeeding, due to undercounting of WIC participants. The representativeness of the WIC population may have been compromised, since higher risk groups were probably undersampled or had lower response rates. Low-income WIC recipients were more likely less literate and possibly less likely to receive, complete, and return a self-administered mail questionnaire (response rate ranged between 54 and 65 percent). WIC respondents were more likely to come from rural areas, to be multiparous, to be adolescent or young, to have borne prematurely, to have had less education, to have lower family income, and to have infants of lower birthweight.

Responses were weighted to adjust for demographic differences between the sample women and the population as a whole. WIC participants breastfed less frequently and for shorter durations than controls. The incidence and duration of breastfeeding increased over time, with the increase among WIC participants about as great as among controls.

Given socioeconomic and other probable disparities between the WIC and control groups, these results do not suggest that WIC benefits were associated with increased breastfeeding.

Table II-B-8 (continued)

Results (continued)		% Positive or correct response
	Improved health	
	Client noted improved health	60
	Program satisfaction	
	Good to super	100
	Not satisfied with lecture format	44
	Staff should consider cultural and family backgrounds	51
	Satisfied with scheduling system	90
Comment	• No comparison group. No evidence that results follow from WIC nutrition education program.	

Table II-B-8

Healthwise, Inc. (1980)

Population studied	WIC participants who received WIC nutrition education classes (n=3) and individual counseling sessions (n=6).	
Assignment method/ research design	Questionnaire (n=98), client interviews (n=12), and observation of nutrition education classes (n=3) and individual counseling sessions (n=6).	
Study group		
Number	98	
Treatment	WIC	
Control group		
Number	None	
Treatment	--	
Results		% Positive or correct response
	WIC program addresses client needs	60
	Knowledge	
	Remember their diet deficiencies	86
	Know deficiency can cause health problem	70
	Can list appropriate health problem	68
	Know symptoms of anemia and high iron foods	73
	Can list one high Vitamin C food	85
	Recognize importance of prenatal visits	85
	Believe WIC foods don't assure adequate diet	51
	Believe breastfeeding is the preferred feeding for infants ≤6 m of age	41
	Believe smoking during pregnancy increases infant health problems	77
	Believe alcohol during pregnancy increases infant health problems	88
	Practice	
	Counseling session helped to decide other foods to buy	82
	Stopped smoking	46
	Stopped drinking	48
	Program helped to:	
	Save money	96
	Improve meal preparation	87
	Plan meals ahead	71
	Buy more fruits and vegetables	79
	Buy greater variety of food	78
	Take more responsibility of own health	89

(continued)

II-B-8. Healthwise, Inc. 1980. "WIC nutrition education evaluation final report." Submitted to Idaho Department of Health and Welfare, WIC Program Office, Boise, Idaho.

Healthwise, Inc., (1980) evaluated the nutrition education component of the WIC program at the Central District Health Department in Idaho. The methods of evaluation included a questionnaire completed by 98 participants (pregnant women and mothers), 12 client interviews, observations of three nutrition education classes and six counseling sessions, and staff interviews. The methods of selection of participants were not reported.

Much of the data reported was summarized in statements of the program strengths and weaknesses. In the client questionnaire, 60 percent of clients reported that the nutrition education program addressed their needs, and 60 percent of clients reported improved health; however, 100 percent rated the program as good to super. The program was reported by clients to change food buying, health, and meal planning practices.

Between 41 and 88 percent answered correctly on 10 nutrition and health questions.

II-B-7. Haddad, L. J., and C. E. Willis. 1983. "An analysis of factors leading to early enrollment in the Massachusetts Special Supplemental Feeding Program for Women, Infants, and Children." Research Bulletin No. 682. Massachusetts Agricultural Experiment Station, University of Massachusetts at Amherst.

Haddad and Willis (1983) gathered information from Directors of 11 WIC centers in Massachusetts, on a subset of 1,270 of the subjects studied by Kotelchuck et al. (1981), to assess associations between maternal and program characteristics with the decision among high-risk women at what stage of gestation to enroll in WIC. The study shares the problem of the Kotelchuck evaluation in equating duration of WIC benefit with time of program entry, without taking length of gestation into account. Only those maternal characteristics that were available from program records could be studied, and parity of the mother (and the length of time a program had been in operation) were related ($p < 0.05$) to early enrollment.

Table II-B-6

Endres et al. (1981)

Population studied	Pregnant women in 22 counties in Illinois July 1978 through April 1979.
Assignment method/ research design	10% of WIC clients for 24-hour dietary recalls (sampling method not specified) compared to women applying for certification.
Study group	
Number	115
Treatment	WIC intervention for 6 months
Control group	
Number	651
Treatment	Women requesting WIC certification
Results	

	Mean intakes as % RDA[a]	
	WIC	Non-WIC
Energy (kcal)	77	68
Protein (g)	105	91
Vitamin C (mg)	194	150
Calcium (mg)	81	66
Iron (mg)	82	64
Vitamin A (IU)	112	87

Mean intakes of thiamine, riboflavin, niacin, folacin, Vitamin B6, Vitamin B12, Vitamin D, magnesium and zinc were also significantly higher for the WIC population.

(Only Vitamin E intake was not significantly higher for the WIC group.)

	% of women consuming WIC foods	
	WIC	Non-WIC
Milk	74	67
Cheese	22	22
Eggs	37	37
Juices	31	23
Cereals	9	5

No significant difference in nutrient intake per 1,000 kcal.

Comment

- Comparability of control group uncertain (i.e., eligibility criteria and gestational age). Although two groups stated to be of similar SES, no data provided.
- Possible reporting bias (i.e., those requesting WIC certification may underreport consumption to get certified).

[a]All differences significant $p < 0.05$.

II-B-6. Endres, J. M., M. Sawicki, and J. A. Casper. 1981. "Dietary assessment of pregnant women in a supplemental food program." J. Amer. Dietetic Assoc. 79:121-126.

Endres et al. (1981) measured dietary intakes of WIC and unsupplemented pregnant women in 22 counties in Illinois with one 24-hour dietary recall. The 115 WIC women received benefits for six months, and the unsupplemented 651 women were applying for WIC certification. The authors found a significantly higher intake ($p < 0.05$) among supplemented women for all nutrients analyzed except Vitamin E. There were no significant differences in nutrient density.

Eggs and cheese were consumed by 37 and 22 percent, respectively, of WIC and control women (n.s.). WIC cereals were consumed by more WIC women (9 vs. 5 percent, n.s.) as were WIC juices (31 vs. 23 percent, n.s.). Milk was also consumed by more WIC women (74 vs. 67 percent, n.s.). Powdered milk and skim milk were excluded from this analysis.

The comparability of the study groups was uncertain. Unsupplemented women applying for WIC might have underreported intake in order to increase the likelihood of being certified. The proportion of the unsupplemented group eligible for WIC was not specified, nor was the stage of gestation of either group: the supplemented group almost surely was nearer term. On the other hand, if the unsupplemented group included many late registrants for care, they were likely to be behaviorally and socially different from WIC recipients. The authors stated that the two groups were of similar socioeconomic status, but no data were provided.

Table II-B-5

Drayton (1982)

Population studied	First 25 high risk pregnant women who were certified eligible for WIC benefits in three centers in Illinois, 1981.
Assignment method/ research design	Twenty-four hour dietary recall and nutrition knowledge questionnaire given at WIC certification and 6-8 weeks postpartum or at recertification.
Study group	
Number	75
Treatment	WIC
Control group	
Number	None
Treatment	
Results	Significance of post-test scores, controlled for pretest score, by analysis of covariance

	Background of nutrition educator	Time spent receiving nutrition education
Knowledge of		
Milk/vitamin D/calcium	*[a]	NA
Caloric intake	*[b]	*[b]

No significant relationships with knowledge of general nutrition, intake of Vitamin C, iron, Vitamins A, B12, B6, C, and D, iron, protein, calcium and folacin or with hematocrit.

Type of nutrition education defined as basic contact, basic + secondary contact, or basic + secondary + high risk contact, unrelated to outcome.

Comment	• Sample sizes were small; no control group.

*$p < 0.05$ ($n = 77$).

[a]Knowledge significantly greater if counseled by nutrition aide vs. registered dietician or graduate student.

[b]Caloric intake higher if counselor was registered dietician, and with increased duration of nutrition education.

II-B-5. Drayton, P. K. D. 1982. "An evaluation of the women, infants, and children nutrition education intervention program for high risk pregnant women in three centers of Illinois." Doctoral thesis. Southern Illinois University at Carbondale, Illinois.

Drayton (1982) studied 25 pregnant women at each of three WIC centers in Illinois at the time of WIC certification and again at 6 to 8 weeks postpartum or at recertification, from 1979 to 1981. The Nutrient Dietary Data Analysis form (based on a 24-hour dietary recall) and a nutrition knowledge questionnaire (developed by the author) were used. WIC records were reviewed for hematocrit level and extent and type of nutrition education. Postpartum hematocrit levels, the percentage of the RDA consumed for specific nutrients, and nutrition knowledge scores were analyzed by the effects of various types of nutrition education methods (basic contact only, basic plus secondary contact, or basic plus secondary plus high-risk contact), the background of educators (registered dietician, food and nutrition graduate student, or nutrition aide), and varying lengths of time spent on education.

Postpartum test scores were controlled for prepartum scores. Postintervention nutrition knowledge was significantly greater for milk/Vitamin D/calcium, one of five categories, if the nutrition educator was a nutrition aide. The type of information provided and the time spent by education were not related to changes in nutrition knowledge. Postintervention hematocrit levels did not vary as a function of the background of the educator, nor the type or extent of education. Caloric intake was significantly greater with increased duration of education and when the nutrition educator was a registered dietician. There were no other significant relationships to reported intake.

Sample sizes were small, and there was no control group. Only postintervention hematocrit levels were presented.

Table II-B-4

Comptroller General of the United States, (1979)

Population studied	Local WIC programs and individuals in Illinois, Louisiana, New York and Washington.
Assignment method/ research design	Review of records. Visits to WIC sites.
Study group	
Health services analysis:	
Number	20 WIC sites 500 WIC recipients
Certification criteria:	
Number	76 WIC recipients
Nutritional assessment:	
Number	125 WIC recipients
Treatment	WIC
Control group	
Number	None
Treatment	--
Results	

Health services

	Available/ received (%)
Health services available at site, or by agreement with outside source	70.0
Health services received by individuals[a]	86.5

Nutritional risk assessment (%)

	No assessment	Improper certification
Washington	60 (125)	9 (51)
Louisiana	NA	20 (25)

Comment

- Methods of selection of states, clinic sites, and individuals not reported.

( ) = n.

[a]Data unavailable for 107 cases.

II-B-4. Comptroller General of the United States (1979). "The Supplemental Food Program for Women, Infants, and Children (WIC)--How can it work better?" Washington, D.C.: United States General Accounting Office.

The Comptroller General's Report (1979) is a description of several components of the WIC program at sites in Illinois, Louisiana, New York, and Washington. Information was obtained from visits and reviews of State and local WIC agencies and from reviews of records of individual participants. The report focuses on weaknesses of implementation of the program, not outcome or effects, and recommends ways to improve the program. Program elements reviewed were integration with health care, nutritional risk assessment, composition of food packages, nutrition education, and the need for evaluation of the program.

Although much of the information in the report is qualitative, there was a review of available health services at 20 WIC sites (how the sites were chosen is not specified). Six did not provide either prenatal or pediatric services, either at the site or by contract with outside agencies. It was not, however, indicated whether these six sites served both prenatal and childhood WIC clients. Some 500 individuals were chosen for record review (the method for selection was not stated), but 107 charts were not found. Of the other 393 individuals, 86.5 percent received health care services and 13.5 percent did not.

Criteria of nutritional risk varied by State. For instance, risk for anemia was defined in Illinois as hemoglobin under 13 grams-percent (g-percent), in Louisiana, under 11 g-percent; in New York, under 12 g-percent; in the Seneca Indian Nation, under 12 g-percent; and in Washington, under 11.5 g-percent.

Whether WIC nutritional risk criteria were met by recipients was assessed in Washington and Louisiana. In Washington, records of 51 participants at three clinics were reviewed. Five participants (9 percent) did not meet the State's nutritional risk criteria. In Washington, 125 records were selected at five clinics. The required nutritional risk assessments were only made in 60 percent of those cases. In Louisiana, five of 25 records reviewed at one clinic showed "improper" certification.

II-B-3. Christie, D. D., and L. B. Gale. 1979. "WIC program involvement in the prevention of mental retardation." Mimeograph. New Jersey State Department of Health, John Fitch Plaza, Trenton, New Jersey.

Christie and Gale (1979) described results of the New Jersey Nutrition Surveillance Program from July 1977 to June 1979 and proposed improvements in the WIC program.

The prevalence of low hematocrit (<31 or <34 percent for children 0 to 23 months and 2 to 5 years of age, respectively) in three community clinics ranged from 14.8 to 31.6 percent. Thus, the WIC program served children with a high rate of anemia. Many of the children in two of the clinics were also growth retarded (rates were not specified).

While the prevalence rates for anemia among WIC participants were high, no conclusions on the effectiveness of WIC services could be drawn from this study.

Table II-B-3

Christie and Gale (1979)

Population studied	Infants and children participating in 3 New Jersey WIC programs.
Assignment method/ research design	--
Study group	
Number	575, Site: North Camden 197, Site: South Camden 928, Site: Plainfield
Treatment	WIC
Control group	
Number	None
Treatment	--
Results	Hematocrit <31% for children 0-23 months of age or <34% at 2-5 years of age, respectively. North Camden 31.6% South Camden 15.3% Plainfield 14.8% WIC population had low weight and height for age, low weight for height and increased weight for height >95th percentile.

Table II-B-2

Bendick et al. (1976)

Population studied	Current and former WIC participants and staff in 96 WIC clinics in 30 states in operation between 1974 and 1975.
Assignment method/ research design	Stratified random sample of WIC clinics by geographical area, size of caseload, rural vs. urban location, ethnic group served and diversity of procedures and policies within programs. Structured interviews with administrators and current and former WIC clients.
Study group	
Number	3,149
Treatment	Current WIC participants
Number	448
Treatment	Former WIC participants
Control group	
Number	None
Treatment	--
Results	Number of visits for preventive health care

	WIC[a]	Non-WIC[a]
Women[b]	5.8 (72)	5.1 (72)
Infants[c]	3.8 (90)	3.0*** (87)
Children[d]	3.9 (85)	2.2*** (78)

81% (2,855) of WIC households were using WIC foods in preparing family meals.

*** $p < 0.001$.
( ) = n of clinics.

[a]Estimates reported by 96 WIC Clinic Administrators of WIC participants and "comparable non-WIC" clinic users.

[b]Women: Total number of prenatal visits per pregnancy.

[c]Infants: Number of visits to well-child clinics during first 6 months.

[d]Children: Number of visits of well-child clinics between 1st and 4th birthdays.

II-B-2. Bendick, M., T. H. Campbell, D. L. Bowden, and M. Jones, The Urban Institute. 1976. "Efficiency and effectiveness in the WIC program delivery system." Miscellaneous Publication No. 1338, 1-216. U.S. Department of Agriculture.

Bendick et al. (1976) of the Urban Institute conducted a study at 96 randomly sampled WIC clinics in 60 program areas across the country. The sample was stratified by the size of the population served, region of the country, and system of WIC food distribution. The study used interviews and self-completed questionnaires by clinic staff to ascertain characteristics of WIC programs and participants. In addition, active and former WIC participants and a small sample of nonparticipants were interviewed. The data from the control sample were analyzed and reported separately.

The study described services provided by WIC clinics and client satisfaction with these services. About 96 percent of WIC participants were satisfied with the way they received WIC foods. About 65 percent of sample clinics used retail purchase for food distribution. Not surprisingly, dissatisfied participants had higher costs, experienced greater inconvenience in getting to WIC clinics, and had difficulty in arranging child care. Number of visits for preventive health services (estimated by clinic staff, not counted from records or estimated by clients) was greater among pregnant women receiving WIC (5.8 vs. 5.1 visits among non-WIC women [n.s.]). The estimated number of well-infant visits during the first 6 months and between the first and fourth birthdays was greater for WIC recipients (for infants, 3.8 vs. 3.0 in the non-WIC group ($p < 0.001$); for children, 3.9 vs. 2.2 for non-WIC children [$p < 0.001$]). Nutrition counseling was given in about 70 percent of clinics in 1975, with only 12 percent of WIC participants judging that they had learned something.

Effectiveness of WIC services was judged from estimates by WIC clinic administrators and current and former WIC participants, but without a comparable control sample.

Table II-B-1

Argeanas and Harrill (1979)

Population studied	Lactating women in Fort Collins, Colorado, 1978.
Assignment method/ research design	Twenty-four hour dietary recall, demographic and other information (maternal eating habits, infant feeding practices, etc.) collected within 6 weeks of delivery and 2 months later.
Study group	
Number	11
Treatment	WIC
Control group	
Number	5
Treatment	None (middle income)

Results

Mean intake and % RDA

	WIC				Controls			
	Weeks postpartum							
	0-6		8-15		0-6		8-15	
	Mean intake	% RDA	Mean intake	% RDA	Mean intake	% RDA	Mean intake	% RDA
Energy (kcal)	1,729	69	2,039	81	2,438	97	2,356	94
Protein (g)	87.1	131	101.1	153	118.0	179	99.6	151
Calcium (mg)	980	82	1,003	84	1,801	150	1,382	115
Iron (mg)	13.4	74	15.2	84	15.3	85	15.7	87
Vitamin A (IU)	3,749	62	8,616	144	6,391	106	6,799	113
Thiamin (mg)	1.03	79	1.37	105	1.34	103	1.22	94
n	11		11		5		5	

Comment

- Controls had higher income than study group.

II-B-1. Argeanas, S., and I. Harrill. 1979. "Nutrient intake of lactating women participating in the Colorado WIC Program." Nutrition Reports International 20(6):805-810.

Argeanas and Harrill (1979) compared the dietary intake of lactating women in Fort Collins, Colorado, eleven enrolled in the WIC program and five controls, within 6 weeks postpartum and 2 months after the initial interview. Height and weight were measured at both interviews. The caloric intake of WIC participants increased by 310 kilocalories, or from 69 to 81 percent of the normative level for pregnant women set by the Food and Nutrition Board of the National Academy of Sciences (2,400 kcal), over the 2-month period, while controls reduced caloric intake from 97 to 94 percent of the same normative level. Though WIC recruitment criteria were not specified, the study women may have been recruited based on inadequate nutritional patterns, such as low caloric intake. Thus, this increase could, in part, have been due to regression to the mean. The mean intake of all measured nutrients except Vitamin C increased in WIC participants. Mean body weight declined by 2.1 and 1.6 kilograms among WIC and non-WIC women, respectively.

The sample was small and the control and study groups were not comparable; controls had higher mean income. Actual income and other demographic data were not reported.

Appendix II-B; Individual review of studies, primarily addressing issues other than health effects of the WIC program.

These detailed reviews are presented as a matter of record, even though they do not relate centrally to health outcome.

Table II-A-29

Williams (1982)

Population studied	Participants in Wyoming WIC Program, 1978-80.
Assignment method/ research design	Comparison of birth records between prenatal and postnatal WIC results.
Study group	
Number	211
Treatment	WIC benefits for less than 3 months
Number	295
Treatment	WIC benefits for 3 or more months
Control group	
Number	750
Treatment	Postnatal WIC recruits

Results

Birthweight <2,500 grams (%)

Racial group	Prenatal WIC Duration of benefits (months) <3	≥3	Total	Postnatal WIC	Total
White	16.2 (148)	8.4 (202)	11.7	13.9 (588)	13.1
Hispanic	4.4 (45)	3.3 (59)	3.8	15.3 (111)	9.8
Other	0.0 (18)	5.9 (34)	3.9	17.6 (51)	10.7
Total	12.3	7.1	9.3	14.4**	12.3

Comment

- Results by duration of treatment confounded by duration of gestation. Control group (postnatal WIC recruits) probably biased to include excess preterm delivery; postpartum certification may have been due to low birthweight.

** $p < 0.01$.
( ) = n, denominator.

II-A-29. Williams, J. T. 1982. "Wyoming WIC Evaluation." Unpublished letter to Food and Nutrition Service.

Williams (1982) described an assessment of the WIC program in Wyoming from 1978 to 1980 in a letter to the Department of Agriculture. He studied the impact of WIC on outcome of pregnancy among high-risk women, whether the WIC program was functioning as an integral component of health care, and the needs of the population served. Rates of low birthweight of infants of mothers who participated in the WIC program for 3 months or more (n=295), less than 3 months (n=211), and who were recruited into the WIC program postpartum (n=750), were 7.1 percent, 12.3 percent, and 14.4 percent, respectively. The comparability of study and control groups was uncertain. The control group of postnatal WIC recruits was likely to have been at higher risk than the prenatal WIC recipients. Comparisons by duration of WIC benefits were subject to confounding by duration of gestation, and there was bias towards short gestation among the control group, since some control women might have enrolled in WIC during pregnancy if they had not delivered prematurely. In addition, postpartum recruitment might have been due to low birthweight and/or prematurity.

Monthly computerized reports of referrals made by the WIC staff for immunization services and to well-child clinics, prenatal classes, private physicians, and other health care services were reviewed to assess integration within the WIC program.

Results were preliminary and are not yet available in a formal report or publication.

Table II-A-28

Weiler et al. (1979)

Population studied	Infants certified November 1976-September 1977 in WIC programs in Fayette County, Kentucky, because of nutritional anemia. Hemoglobin measured at recertification (median age: 59 days) and recertification (median age: 230 days).
Assignment method/ research design	Pre-post comparison.
Study group	
Number	37
Treatment	Infants certified for WIC because of anemia, with repeated measurement at recertification.
Control group	
Number	None
Treatment	--
Results	Mean change in hemoglobin at recertification (g/dl)

Age at certification		
<6 weeks	2.9	(9)
6 weeks-6 months		
Initial value > expected	-.5	(11)
Initial value < expected	1.0	(17)
Total	1.0	
% increasing	73	
Assumption of no change expected	p = 0.0009	

Comment

- Repeated measurements for only 37 of 311 infants certified because of nutritional anemia were available at recertification.
- Observed results consistent with regression to the mean.

( ) = n.

II-B-6. Endres, J. M., M. Sawicki, and J. A. Casper. 1981. "Dietary assessment of pregnant women in a supplemental food program." J. Amer. Dietetic Assoc. 79:121-126.

Endres et al. (1981) measured dietary intakes of WIC and unsupplemented pregnant women in 22 counties in Illinois with one 24-hour dietary recall. The 115 WIC women received benefits for six months, and the unsupplemented 651 women were applying for WIC certification. The authors found a significantly higher intake ($p < 0.05$) among supplemented women for all nutrients analyzed except Vitamin E. There were no significant differences in nutrient density.

Eggs and cheese were consumed by 37 and 22 percent, respectively, of WIC and control women (n.s.). WIC cereals were consumed by more WIC women (9 vs. 5 percent, n.s.) as were WIC juices (31 vs. 23 percent, n.s.). Milk was also consumed by more WIC women (74 vs. 67 percent, n.s.). Powdered milk and skim milk were excluded from this analysis.

The comparability of the study groups was uncertain. Unsupplemented women applying for WIC might have underreported intake in order to increase the likelihood of being certified. The proportion of the unsupplemented group eligible for WIC was not specified, nor was the stage of gestation of either group: the supplemented group almost surely was nearer term. On the other hand, if the unsupplemented group included many late registrants for care, they were likely to be behaviorally and socially different from WIC recipients. The authors stated that the two groups were of similar socioeconomic status, but no data were provided.

II-A-6. Collins, T., J. Leeper, R. S. Northrup, S. DeMeillier. 1981. "Integration of WIC program with other infant mortality programs. Final report." Appalachian Region Commission Report, University of Alabama, Tuscaloosa, Alabama.

Collins et al. (1981) reported on the integration of WIC with other programs aiming to lower infant mortality in six Appalachian Regional Commission counties of Alabama. Data for a limited number of outcomes were reported from interviews with and records of the women and from birth certificates. There were 342 WIC participants and 178 pregnant controls. (There were also 121 nonpregnant controls used because of the scarcity of pregnant controls.) There were no significant differences in numbers of clinic visits, hematologic indices, weight gain, or birthweight, but WIC recipients were significantly more likely to receive iron supplementation. The absence of observed benefit could be due to skimming; i.e., women at higher risk may have been recruited into WIC leaving a residual of lower risk women as controls. For instance, the proportion of women with yearly incomes above $8,000 was 10.3 percent in the WIC group, but 17.8 percent among controls.

The mother's plans on whether and how long to nurse were studied. More WIC women planned to nurse and for longer duration, although the differences were not significant. The nonsignificant differences between WIC women and controls for nursing, alcohol intake, and smoking were derived from cross-sectional survey; inference on the lack of effect of WIC counseling depends on the assumption that WIC recipients and controls were initially comparable, but no pretreatment data were available.

Table II-A-5 (continued)

Comment	• Differences from recruitment to first followup visit confounded by regression to the mean; effect of regression to the mean less for change after first followup. • Subset of WIC children with data for two followup visits may not be representative.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Significance tests are for comparison between first and second followup visits.

II-A-7. Deterding, J., A. Wickiser, and J. Smith. 1983. "The benefits of the WIC program in three Indian communities." University of Nebraska Medical Center, Omaha, Nebraska.

Deterding et al. (1983) evaluated the growth patterns and hemoglobin values of 433 Indian children enrolled in WIC programs from three tribes in northeastern Nebraska during the early 1980's. Criteria for eligibility in the WIC program were anemia, low serum vitamin levels, or impaired growth. About 300 of these children were enrolled in the WIC program for up to 27 months. Height, weight, head circumference and hemoglobin levels were recorded for each child at recruitment and after additional visits, with an average of 6 months between visits. Standardized growth curves from the National Center for Health Statistics (NCHS) were used to determine the percentile of height for age, weight for age, weight for height, and head circumference for age at each visit.

At the initial visit one-third of the children were obese (weight for age and/or weight for height above the 84th percentile). The mean percentile of weight for age was 64.0, and of weight for height, 63.7. Initially, 13.3 percent of the children older than 12 months of age were anemic (using a standard of hemoglobin <11.0 g/dL).

Growth was plotted against time and the slope of change with time was calculated. The authors presented mean percentile change per month by average percentile during the study, ≤16.0, >16.0 to ≤84.0, and >84.0. Given regression to the mean, measurements for the extreme groups would tend to become less extreme, independent of treatment. Thus, the weighted mean change for the total population was calculated. There were significant increases in both stature and weight for age compared to NCHS growth standards. Change in weight for height was not significant. These results are still subject to regression to the mean, since one of the recruitment criteria was impaired growth.

Blood hemoglobin levels were reported for children over 1 year of age. About 13 percent had low hemoglobin values at initial visit, but only 4 percent by the second visit, approximately 6 months later. This change was probably due in part to regression to the mean, since anemia was one of the recruitment criteria.

Table II-A-6

Collins et al. (1981)

Population studied	Low income women attending health department clinics in six Appalachian counties in Alabama, 1981.		
Assignment method/ research design	Comparison of WIC participants and nonparticipants on interview items and on birth and pregnancy data taken from records.		
Study group			
Number	342		
Treatment	WIC		
Control group			
Number	178		
Treatment	--		
Results		WIC	Controls
	Hemoglobin (g %)	12.9 (83)	12.8 (80)
	Hematocrit (%)	36.3 (204)	36.9 (72)
	Prenatal visits (n)	9.9	9.8
	Iron supplementation (%)	88.3	72.3***
	Maternal weight gain (lb)	25.8	24.9
	Birthweight, <2,500 g (%)	6.4	3.8
	Mean birthweight (g)	3,241	3,241
	Pregnancy complications (%)	2.7	2.8
	Infant feeding practices		
	Discussed breastfeeding with family members/health professionals (%)	68.8	50.3**
	Planning to nurse (%)	18.5	16.4
	Planned months of nursing (n)	3.3	2.7
	Reasons for choosing breastfeeding (%)		
	More convenient	65.1	39.3*
	Breastmilk better	96.8	89.3
	Reasons for choosing bottlefeeding (%)		
	Formula just as good	66.4	51.4**
	More convenient	76.7	69.3
	Don't know how to nurse	30.2	20.0*

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
( ) = n.

II-A-8. Development Associates, Inc. 1979. "Evaluation of the WIC migrant demonstration project: A final report." Unpublished report. Submitted to Food and Nutrition Service, U.S. Department of Agriculture. Arlington, Virginia.

Development Associates, Inc. (1979), conducted an evaluation of the WIC Migrant Demonstration Project to assess provision of health services to migrants and the effectiveness of administration and reduction of barriers to participation. Questionnaires were administered to all 13 participating State agencies, to one local agency each in Colorado, Iowa, Kansas, Missouri, Nebraska, North Dakota, Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin (the upstream States), and to all 13 participating local agencies in Texas.

In 11 of the 13 local agencies in Texas (those with more than 19 participants and eligible nonparticipants), one participant per household was interviewed. Separate sampling frames were used for women (with or without children) and children (with no participating women). It is unclear whether selection of subjects within agencies was random. About 24 percent of the 259 participants were excluded because they did not meet study criteria or could not be located.

Some 49 eligible nonparticipants were located at six of the local agencies. It is unclear whether these migrants were comparable to the participants. Virtually no data are provided on this group.

To assess the nutritional benefits of the demonstration project, medical records of 79 WIC Demonstration Project participants in Texas were reviewed in August and September of 1978. Participants in the regular WIC program served by the same local agencies and who had been certified twice during the study period (1978) served as controls (n=140). Only 65.4 percent of the study group had been certified twice. Data on the socio-economic status and ethnicity of the two groups were not provided, and thus it is unclear whether the groups were comparable.

Services provided by the Texas local agencies were compared to those of the upstream local agencies. In Texas, 90 percent of the permanent staff were bilingual, compared to 14 percent in the upstream agencies. (The upstream agencies did add extra staff for the WIC Demonstration Project, but whether the staff were bilingual was not reported.)

The use of Verification of Certification (VOC) cards to facilitate transfer of WIC certification between States was assessed. Of 12 upstream States, 6 reported that migrants arrived only "rarely" with the VOC cards. Of 13 local agencies in the upstream States, 7 reported that migrants from outside the State "rarely" or "never" arrived with VOC cards. In Texas, 1 of the 13 agencies reported that it received VOC cards from other States, but only "rarely."

To assist migrants and local agencies in locating WIC programs and health facilities in migrant areas, a program directory was designed by the

Table II-A-7

Deterding, et al. (1983)

Population studied	Children enrolled in WIC from the Omaha, Winnebago, and Santee Indian Tribes of Northeastern Nebraska (certified because of anemia, low serum vitamin levels, or impaired growth).
Assignment method/ research design	Growth (height for age, weight for age, weight for height, and head circumference) and hemoglobin at initial visit and at subsequent visit about 6 months later.
Study group.	
Number	443
Treatment	WIC
Control group	
Number	None
Treatment	--

Results

	Mean change in percentile/ month[a]	
Height for age[b]	.77***	(162)
Weight for height[b]	.08	(140)
Weight for age[c]	.33**	(304)

Hemoglobin	Initial visit	Post treatment[d]
% <11.0 g/dl[e]	13.3	4.0** (173)

Comment

- Impossible to distinguish WIC effect from regression to the mean.
- No control group.

**p < 0.01.
***p < 0.001.
( ) = n.

[a]≥ 24 months of age at initial visit.

[b]≥ 1 month of age at initial visit.

[c]Calculated from author's data.

[d]Approximately six months after initial visit.

[e]>12 months of age at initial visit.

Table II-A-8

Development Associates, Inc. (1979)

Population studied	WIC Migrant Demonstration Project in 13 States. All State and 13 local agencies in Texas with WIC migrant demonstration projects and one local agency in all other States. Individuals in 11 of 13 local Texas agencies first certified before 5/1/83 were interviewed, and eligible non-WIC migrants.
Assignment method/ research design	Minimum of 17 women or children selected per local agency. Retrospective review of medical records of Texas participants certified at least twice. Medical records of WIC participants were reviewed.
Study group	
Number	13 State agencies
Treatment	--
Number	25 local agencies
Treatment	WIC Migrant Demonstration Project
Control group	
Number	--
Treatment	--
Results	State and local agencies

Use of WIC Program Directory

% reporting	State agencies	Local agencies	Individuals
No problems	15	28	93.6
Serious problems	23	28	-
	(13)	(25)	(94)*

(* only 50.5% of individuals received directories)

Comment
- Unclear whether sample selection was random.

(continued)

WIC Demonstration Project. Of 182 participants interviewed, 50.5 percent had received the directory. Of the 94 individuals receiving the directory, 93.6 percent reported no problems in using it. On the other hand, of the 25 local agencies, only 7 had no problems using it, 5 had few problems, 6 had some problems, and 6 had serious problems. Among the 13 State Administrators, 2 had no problems, 8 had some problems, and 3 had serious problems using the directory.

Nutrition education modules developed by the Food and Nutrition Service (FNS) were evaluated by questionnaires to State and local agencies and to participants. About 51 percent of participants reported never having encountered the nutrition education flip charts, and 46 percent had received nutrition education handouts prepared by FNS. Of the 49 percent that had encountered the flip charts, all reported that they were helpful, and 93 percent thought the use of the flip charts should be continued.

In the medical record review, women in the demonstration project and women in the regular WIC program were similar in age, age at first pregnancy, number of previous pregnancies, rate of past miscarriages, and of preterm and low-birthweight delivery.

In Texas, reasons for eligibility were specified for 85 percent of Demonstration Project women and 93 percent of regular WIC women. Inadequate dietary pattern was the most common eligibility criterion (78.8 percent in the demonstration group and 89.3 percent in the regular group) followed by inadequate growth pattern (51.5 and 64.9 percent, respectively) and iron deficiency anemia (33.3 and 29.0 percent, respectively). Eligibility criteria data were not presented for infants or children.

If the women with one or two certifications were included in the analysis, hematocrits increased from first to second certification from 35.5 to 38.4 percent and from 35.5 to 38.6 percent for those enrolled in the demonstration project and regular programs, respectively. In 75 Demonstration Project children aged 1 to 5 years who were certified twice, the hematocrit increased from 34.1 to 34.3 percent (n.s.). Among the 81 children enrolled in regular WIC programs who were certified twice, the hematocrit rose from 33.8 to 34.4 percent ($p < 0.05$). For 31 infants enrolled in the Demonstration Project and certified twice, mean hematocrit rose from 32.2 to 34.2 percent. Among 33 infants in regular WIC programs, hematocrits rose from 31.0 to 33.3 percent. Increases in mean hematocrit were, in part, a function of regression to the mean.

Of 143 Demonstration Project children, 18.9 percent had length below the 10th percentile and 8.4 percent had length above the 90th percentile at first certification. At second certification, 22.6 percent of the 115 children were below the 10th percentile, and 13.0 percent were above the 90th percentile. About 17.8 percent of the 101 children in the regular group were below the 10th percentile, and 8.9 percent were above the 90th percentile of length-for-age at first certification; 25.0 percent of the 100 children were below the 10th percentile at second certification, and 12.0 percent were above the 90th percentile. Since different subgroups of children were measured at first and second certification, what can be inferred from these differences is limited.

Table II-A-8 (continued)

Results

Medical record review

Mean hematocrit levels (%), WIC participants certified twice

	Demonstration project		Regular program	
	1st cert.	2nd cert.	1st cert.	2nd cert.
Women	35.5	38.4 (43)	35.5	38.6 (129)
Infants	32.2	34.2 (31)	31.0	33.3 (38)
Children	34.1	34.3 (75)	33.8	34.4 (81)

Length for age

	Demonstration project 1st cert.	Demonstration project 2nd cert.	Regular program 1st cert.	Regular program 2nd cert.
Infants (<1 year)				
% <10th percentile	24.3	18.4	15.4	15.4
% >10th percentile	12.2	10.0	12.8	12.8
	(74)	(60)	(78)	(78)
Children (1-5 years)				
% <10th percentile	18.9	22.6	17.8	25.0
% >90th percentile	8.4	13.0	3.9	12.0
	(143)	(115)	(101)	(100)

Comment

- Definition of migrants differed across agencies, therefore groups may not be comparable (i.e., not always clear why some migrants were in Demonstration Project and others in regular WIC program).
- Hematologic and anthropometric results confounded by regression to the mean. No data on stage of gestation at recruitment available from most medical records. Not specified whether women were pregnant or postpartum. Hematocrits only available for small proportion of participants.
- No description of economic or ethnic characteristics of those whose medical records were reviewed. Comparability of groups not established.

( ) = n.

Table II-A-8 (continued)

Assignment method/ research design	Individual interviews
Study group	
Number	183
Treatment	WIC Migrant Demonstration Project
Control group	
Number	49
Treatment	Eligible nonparticipating migrants
Results	State and local agencies

Use of verification of certification cards

	Upstream agencies	Texas agencies
% reporting migrants arrive "only rarely" with VOC cards	58 (12)	8 (13)

Individual interviews

	Use of nutrition education flipcharts %
Encountered flipcharts	51
Reported flipcharts average to very good	100
Recommended continued use	93
n	(182)

Comment

- No data provided on interviews with eligible, non-participating migrants. No data on SES comparability between groups.

Assignment method/ research design	Medical record review
Study group	
Number	79 pregnant and postpartum women, 79 infants (<1 year), 158 children (1-5 years)
Treatment	WIC Migrant Demonstration Project
Control group	
Number	140 pregnant and postpartum women, 78 infants (<1 year), 101 children (1-5 years)
Treatment	Participants in WIC Program

(continued)

conclusion that "part of the program effect could be accounted for by an increase of about 5 days in the gestational duration while a smaller proportion appeared to be a direct one on fetal growth." This increase of 5 days was much longer than might be expected from other research and was more likely not exclusively a program effect but a reflection that those with longer duration of gestation had greater opportunity for longer duration of treatment.

The rate of low birthweight (<2,500 g) delivery among prenatal WIC recipients was 7.2 percent versus 9.2 percent for postnatal recruits ($p < 0.01$), based on nearly the full study sample. This result was subject to selection bias: low birthweight is one of the criteria for postnatal recruitment into the WIC program.

Comparing dietary intake of women enrolled in the program for at least 3 months with their initial intake, energy intake was not significantly increased. During pregnancy, protein, calcium, phosphorus, iron, thiamin, riboflavin, ascorbic acid, and folacin intake did increase significantly. The only significant increases among postpartum women were in thiamin and ascorbic acid intake. These results cannot be interpreted as longitudinal change, since they were drawn from repeated cross-sectional analyses of mostly different women. For instance, in pregnancy, there were 2,754 women with initial values but only 299 with greater than 3 months of WIC participation. Conversely, there were only 179 women with initial values postpartum, but 421 with greater than 3 months of participation. Although these data were adjusted for duration of gestation, age, ethnic origin, income poverty ratio, and project location, it remains uncertain that the groups compared were, in fact, initially comparable.

Similarly, there were over 18,000 infants and children with initial visits but fewer than 5,000 reassessed after 11 months of treatment. Children under the age of 1 year who had been on the program for 3 months had decreased calcium, phosphorus, and protein intake and increased intake of other micronutrients, with no significant change in energy. On the other hand, for children over 1 year of age, intake of all the measured nutrients increased significantly during the course of WIC participation, without significant energy increase.

Children's weight, height, head circumference, and nutritional index (weight divided by height 1.6 multiplied by 10) were significantly higher among those enrolled in the WIC program, compared to new recruits. The meaning of this significant difference is uncertain, since, in Table 3 of Edozien et al. (1976b), significance values are given jointly, combining both the 6- and 11-month followups. Also the effect of adjustment is unclear; it was stated that the "p value is probability after adjusting for age, sex, ethic origin, income poverty ratio, birthweight, difference in height of growth curve between low birthweight and normal birthweight babies, and difference in slope of the growth curve of the above two categories of infants and children." It is not obvious what the aims were of adjustment for these last two issues, nor their effect on the reported results.

II-A-9. Edozien, J. C., B. R. Switzer, and R. B. Bryan. 1976a. "Medical evaluation of the Special Supplemental Food Program for Women, Infants and Children (WIC)" (6 volumes). University of North Carolina, School of Public Health, Chapel Hill, North Carolina.

Edozien, J. C., B. R. Switzer, and R. B. Bryan. 1976b. "Medical evaluation of the Special Supplemental Food Program for Women, Infants, and Children." Select Committee on Nutrition and Human Needs, United States Senate. Washington, D.C.: U.S. Government Printing Office.

Edozien, J. C., B. R. Switzer, and R. B. Bryan. 1979. "Medical evaluation of the Special Supplemental Food Program for Women, Infants and Children." Amer. J. Clinical Nutrition 32:677-692.

Edozien et al. (1976a,b; 1979) studied over 4,000 pregnancies and 18,000 infants and children in 19 WIC projects in 14 States from 1973 through 1976. There were no controls; those already enrolled in the WIC program were compared to new recruits, either women at the same stage of gestation or infants and children of the same age at entry into the program.

Weight gain in pregnancy was significantly greater among women enrolled in WIC, both at several points during pregnancy and overall: the difference in total weight gain was 1.2 kilograms ($p < 0.01$). However, the comparison for the total population is confounded by the likelihood that postnatal recruitment into the WIC program was caused in part by preterm delivery or low birthweight, both associated with low weight gain. The interim results are somewhat confusing, since the authors did not smooth the weight gain curve for initial recruits but rather used the actual mean value for those new recruits during the specified month of gestation. The observed greater weight gains among WIC participants (limited to comparisons between those already in the program and those first entering the program between 24 to 27 weeks, or between 28 to 31 weeks of gestation) appeared to be more due to the unusually low weight gains of those entering the program at those durations of gestation, rather than increased weight gain among the previously recruited.

The relationship between prenatal WIC benefits and birthweight was estimated by linear multiple regression analysis. There were several uncertainties in these analyses. First, although over 4,000 pregnancies were studied, the major inference in this study was drawn from the very few women who were included in the analysis who either had no WIC benefits during pregnancy (n=41) or benefits at 6 months or longer (n=139). The estimated difference in birthweight between these extreme groups was either 136 or 102 grams for two different regression models. However, these differences were confounded by duration of gestation. Those with longer durations of gestation had greater chance to participate longer in the WIC program. In the regression analyses, duration of gestation was not controlled. That such confounding did exist was suggested by the author's

Table II-A-9

Edozien et al. (1976a, b; 1979)

Population studied	19 WIC Projects in 14 States from 1973-76.
Assignment method/ research design	Most outcomes contrasted with values for new enrollees at same stage of gestation or same age.
Study group	Pregnant women
Number	4,125
Treatment	Completed pregnancies
Control group	
Number	None
Treatment	--
Results	Differences in weight gain (kg) between women previously enrolled in program and initial recruits:

Gestation (w)

	20-	24-	28-	32-	36-39	Total
Weight gain (kg):	.24	2.00*	2.23**	.82	.61	1.20**
Fed	(33)	(149)	(130)	(118)	(256)	(772)
Not fed	(371)	(401)	(389)	(361)	(209)	(2,839)

Birthweight (g) and duration of participation in the WIC Program

Duration of participation (months)

Birthweight (g):	0	<3	3-	6+
Model 1:	3,057	3,052	3,125	3,193
Model 2:	3,120	3,094	3,165	3,222
	(41)	(421)	(412)	(139)

(Adjusted for several relevant factors using two different linear regression models, neither including duration of gestation. Model 1 included weight and height; Model 2, weight for height index.)

% Birthweight <2,500 g

Prenatal participants	Postpartum results
7.23	9.21**
(1,651)	(4,976)

(continued)

Since low hematologic values may well have been criteria for recruitment into the WIC program, it is impossible to separate effects of regression to the mean from the observed change over time. Any change between the 6- and 11-month visits, however, would be less subject to regression to the mean, but there was little change between the 6- and 11-month visits in hemoglobin or hematocrit. This could be, in part, due to having reached satisfactory levels before the 6-month visit, but it is very difficult to interpret the implications of the change from 0 to 6 months.

This massive study, therefore, leaves many uncertainties. Were the 19 WIC projects that were studied representative of the universe of WIC programs? Were initial recruits, after adjustment by linear multiple regression for several factors, a reasonable comparison group for those already in the program? Did regression to the mean account for observed differences in growth or hematology? What characterized the one-half to two-thirds of subjects who were not available for 6- and 11-month followup? To what extent were initial values skewed by being related to selection criteria (such as anemia or low height)? Given these many questions, what would appear to be reasonably secure is the fact that children and mothers (at least during pregnancy) receiving supplements did have improved diets. The changes in hematology and growth are confounded by regression to the mean and also potentially confounded by selective followup (as is all of this study). The analysis of mean birthweight was limited both by small numbers of subjects and the confounding of the treatment variable (duration of participation) by duration of gestation.

Table II-A-9 (continued)

Study group	Infants and children
Number	18,339
Treatment	With initial visit
Number	10,313
Treatment	Reassessed after 6 months treatment
Number	4,910
Treatment	Reassessed after 11 months
Control group	
Number	None
Treatment	--

Results

<u>Diet</u>: Differences in daily nutrient intake between children enrolled in WIC and new recruits (mg, unless noted).

	Age of child (months)		
	6-11	12-47	
	Time on program (months)		
	6	6	11
Energy	NS	NS	NS
Protein (g)	-7	3	4
Calcium	-127	85	73
P	-121	72	67
Fe	5.1	1.6	1.5
Vitamin A (IU)	365*	512	627
Thiamine	-.2	.2	.3
Riboflavin	-.2	.2	.3
Niacin	2.4	.6	1.2
Ascorbic acid	19	22	26
Folacin (μg)	NA	31	34
Initial	(912)	(3,584)	(3,584)
Followup	(506)	(1,292)	(1,008)

(Differences adjusted for age, sex, ethnic group, "income poverty ratio," project location; only significant differences shown; all significant at $p < 0.001$ unless noted.)

(continued)

Table II-A-9 (continued)

Results (continued)	Diet: Estimated increase in women's daily nutrient intake after 3 months treatment compared to initial intakes (mg, unless stated; significant values only).

	Pregnancy	Postpartum
Energy	-	-
Protein (g)	4.6*	-
Calcium	123***	-
P	107***	-
Fe	1.0**	-
Vitamin A (IU)	-	-
Thiamine	.10**	.15**
Riboflavin	.22***	-
Niacin	-	-
Ascorbic acid	17**	26**
Folacin (μg)	24***	-
Initial	(2,754)	(179)
>3 months participation	(299)	(421)

Comment

- Pregnant women: Significant weight gain differences, only at 24-27 and 28-31 weeks gestation, appear to be due to nonlinearity (Figure 1, page 198, Edozien et al., Vol. 2, 1976a) of distribution of initial weights.

  Analysis assumed adverse social and medical risk associated with late entry into program could be controlled for by measured social indices.

- Mean birthweight differences were not adjusted for duration of gestation but women with longer gestation had greater chance for longer participation. Text states: "Part of the program effect could be accounted for by an increase of about 5 days in the gestational duration, while a smaller portion appeared to be a direct one on fetal growth."

  No explanation for discrepant numbers between studied pregnancies and those for whom mean birthweight analyzed.

  Difference in rate of low birthweight subject to selection bias: low birthweight a criterion for postpartum certification in the WIC program.

(continued)

Table II-A-9 (continued)

Comment	• Infants and children: Dietary and anthropometric indices are compared after 6 and 11 months of the program with those of new enrollees of the same age. Given constant application of enrollment criteria during study, these comparisons only minimally subject to regression to the mean. However, they assume that any differences between older enrollees and younger enrollees can be controlled by analysis (see text). From data presented, it is not possible to estimate program effects on percent < RDA, nor on percent at 50th percentile in growth indices. • Reported change in hematologic indices subject to confounding by regression to the mean. Initial value one of the criteria for entry into program, and therefore skewed to lower values. Repeated testing would, of necessity, yield higher means, independent of any treatment effect, but of uncertain magnitude.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
( ) = n.

Table II-A-9 (continued)

Anthropometry: Differences between children enrolled in WIC and new recruits.

	Age of child (months)		
	6-11	12-47	
	Time on program (months)		
	6	6	11
Weight (g)	123	240	113
Height (cm)	.23	.51	.56
Head circ. (cm)	.13	.09	.02
Nutritional index			
(Wt./Ht. 1.6×10)	.80	.95	-.06
Initial	(2,756)	(10,947)	(10,947)
Followup	(1,993)	(5,088)	(3,678)

(Differences adjusted for age, sex, ethnic group, "income poverty ratio," birthweight, and "difference in growth curves of low birthweight infants;" significance levels uncertain from reported data; see text.)

Hematology: Change in hematologic and biochemial indices from those at initial visit (not comparisons with new recruits); (all significantly different from initial values at $p < 0.001$ unless noted).

	Age of child (months)		
	6-11	12-47	
	Time on program (months)		
	6	6	11
Hemoglobin (g/100 ml)	.38	.34	.42
Hematocrit (%)	.61	.79	.78
MOHC (g/100 ml)	.51	.24	.45
Initial	(3,363)	(14,959)	(14,959)
Followup	(2,705)	(7,608)	(4,910)
Transferrin (mg/100 ml)	-19.0	2.9*	-20.0
Saturation (%)	NS	-1.3	NS
Initial	(2,316)	(10,569)	(10,569)
Followup	(2,040)	(5,980)	(4,012)

(continued)

Table II-A-10

Fleshood et al. (1983)

Population studied	Tennessee, 1982, all WIC recipients.
Assignment method/ research design	Prenatal WIC recipients compared to those certified postnatally.
Study group	
Number	4,312
Treatment	Number weeks on WIC during pregnancy: 1-12
Number	3,471
Treatment	Number weeks on WIC during pregnancy: 13-20
Number	4,750
Treatment	Number weeks on WIC during pregnancy: 21+
Control group	
Number	7,961
Treatment	No WIC benefits during pregnancy

Results

Duration of WIC benefits (weeks)	% < 2,500 g birthweight
1 - 12	11.0
13 - 20	9.3
21+	5.6
Total	8.5
None (postnatal recruits)	14.4

Comment

- Analysis by duration of WIC benefits confounded by length of gestation. Postnatal recruits probably selected for low birthweight (see text).

II-A-10. Fleshood, L., M. H. Buckner, A. F. Hatchett, J. A. Hayes, J. Seals, C. M. Smith, P. A. Scanlon, J. N. Wallace. 1983. "Is WIC reducing the prevalence of low birthweight and infant mortality?" Paper presented during the 106th American Public Health Association meeting, 1978.

Fleshood et al. (1983) related the frequency of low birthweight (<2,500 g) among WIC recipients in Tennessee in 1982 to duration of WIC services during pregnancy. Rates were highest among postnatal recruits (14.4 percent) and were lower with increased duration of prenatal WIC services (11.0 percent for 1 to 12 weeks, 9.3 percent for 13 to 20 weeks, and 5.6 percent for 21+ weeks). The overall rate for all prenatal WIC recipients was 8.5 percent (versus postnatal recruits, $p < 0.001$). These results cannot be securely interpreted as demonstrating an effect of duration of WIC service. Duration of WIC benefits is confounded by the length of gestation, since length of gestation influences both the duration of prenatal WIC benefits and birthweight (see the discussion of Edozien et al. [1976a,b, 1979] and Kotelchuck et al. [1981]). Moreover, the postnatal WIC recruits are probably a group at higher risk than prenatal recruits for at least three reasons: (1) postnatal recruits (by definition, meeting income criteria) were likely not to have sought prenatal benefits (although some may have applied and not been certified) and thus were likely not to have been as conscientious about health needs as prenatal recipients; (2) low birthweight, or poor postnatal growth associated with low birthweight, may have been criteria by which they were drawn into the WIC program, and thus they were unlikely to be a representative control group (the rate of low birthweight of 14.4 percent was almost twice the State average); and (3) postnatal recruits include some very preterm deliveries that might have been enrolled in WIC, had their pregnancies been carried longer, thus biasing the group towards excess low birthweight.

Table II-A-11

Goldberg (1982)

Population studied	105 black children enrolled in Harlem Hospital WIC program, 18-60 months old.
Assignment method/ research design	Reviewed 390 stratified random charts (of 1,604) of WIC recipients recertified between December 1982-April 1982. 105 met the following criteria: age 18-60 months, black, recertified ≥ 3 times and followed for ≥ 18 months.
Study group	
Number	33 boys, 26 girls
Treatment	Age at onset of WIC (months): Prenatal
Number	6 boys, 22 girls
Treatment	Age at onset of WIC (months): 0-6
Number	9 boys, 9 girls
Treatment	Age at onset of WIC (months): 7-40
Control group	
Number	--
Treatment	USDHEW Natality Statistics, NCHS Growth Charts, and Rudolph's Pediatric Hematologic Standards

Results

	Onset of WIC therapy	
	Prenatal	Postnatal
Mean birthweight (g)	3,219	2,851***
<2,500 g (%)	8.4	26.0*
Weight at 12 months (kg)	10.11	9.54

<10th percentile/NCHS growth curves

	Recertification		
	#1	#2	#3
Weight	7.6	4.7*	4.7*
Length	13.3	10.4	3.8*

% anemic by Rudolph's standards

Age (months)	Anemia defined as Hct <	% Anemic
3-6	29	8.6
6-24	33	5.7
24-60	34	1.0

Comment

- Low birthweight or small postnatal size as criteria for postnatal WIC eligibility confound the comparison of birthweight on growth by age of onset of WIC benefits. No control for socioeconomic or other possible confounding factors. To the extent that anemia was a recruitment criterion, change over time confounded by regression to the mean. Postnatal WIC sex ratio 2F:M. NCHS growth curves and Rudolph's standards not race specific.

*p < 0.05 (vs. initial rate).
***p < 0.001.

II-A-11. Goldberg, H. E. 1982. "An evaluation of the effectiveness of the WIC program in terms of height, birthweight, weight, and hematocrit." Unpublished report. The Mount Sinai Medical Center, New York, New York.

Goldberg (1982) reviewed hospital charts of 390 children, a stratified sample of 1,604 WIC recipients recertified between December 1981 and April 1982 at the Harlem Hospital WIC program in New York City. Of these, 105 recipients met the following criteria for study eligibility: age 18 to 60 months (at last recertification), black, recertified in the WIC program at least three times, and followed for at least 18 months. About 95 percent of Harlem Hospital WIC recipients received public assistance and Medicaid, and 90 percent were from single-parent families.

Those who received prenatal WIC benefits weighed significantly more at birth (368 g, $p < 0.001$) and more at 12 months of age (0.57 kg, n.s.) than those who received only postnatal WIC benefits. The mean birthweight for those with only postnatal WIC benefits was low (2851 g), consistent with the likelihood that low birthweight may have led to WIC enrollment. Prenatal WIC was defined as mother's receipt of WIC for the "entire duration" of pregnancy, but no data on duration of gestation at first WIC visit are reported. Initial WIC certification varied from birth to 40 months of age. Mean age at recertification was not reported; median age at recertification was 6, 12, and 18 months. The analysis of weight at 12 months excluded 37.3 percent of prenatal recipients and 26.1 percent of postnatal recipients who were recertified (and weighed) before 11 or after 13 months of age. About 8.4 percent of study children enrolled in WIC prenatally had birthweights below 2,500 g, compared to 26.0 percent of postnatal recruits. This comparison is confounded to the extent that low birthweight was a criterion for postnatal WIC eligibility, and the higher proportion of girls in this group would account to some extent for lower birthweight. Thus, few conclusions can be drawn from this study on the effect of the WIC program on perinatal outcome.

Fewer children were anemic as they became older. To the extent that anemia was a criterion for initial program eligibility, this change is, in part, due to regression to the mean.

By the third recertification (i.e., at least 18 months on the WIC program), fewer than 5 percent of the children were below the 10th percentile for weight or height. These low rates (much lower than at initial certification) are likely due not only to program benefits but also to regression to the mean (in that impaired growth may have led to program eligibility). There is thus the suggestion of program benefits, but this study does not allow us to draw secure conclusions.

remeasurements, 3 and 6 months after program entry, consistent with under-correction for regression to the mean. If differences were physiological, there is no obvious reason they should not have been sustained beyond 6 months after recruitment, even if the greatest rates of gain were early in program participation.

II-A-12. Heimendinger, G. 1981. "I. The effect of WIC on the growth of infants and children. II. The use of growth standards in assessing WIC impact on infants and children." Unpublished doctoral thesis. Harvard University, Boston.

Heimendinger (1981) abstracted demographic and anthropometric data on all infants and children (active and inactive) from three sites of two Boston WIC programs and on all children registered for care in two health clinics serving the same neighborhoods. The study included 914 WIC and 1,098 control children; all had at least two recorded weights in the first 18 months of life. Children were kept in the control group up to the age that they received WIC benefits. In some analyses, children who received only postnatal WIC benefits were distinguished from those who received both prenatal and postnatal benefits. All comparisons were controlled for age, sex, ethnicity, and birthweight. Length was rarely recorded; comparisons with controls were limited to weight. The author assessed height using NCHS age and sex specific standards (see below).

Mothers' participation in WIC was associated with a 60-gram increase in birthweight ($p < 0.05$), after controlling for sex, mother's age, neighborhood, ethnicity, Medicaid enrollment, birth order, and whether the infant was low birthweight or premature. Controlling for low birthweight probably led to an underestimate of actual difference in birthweight between WIC group and controls. The difference was also subject to selection bias, since low birthweight might have led to postnatal WIC certification.

The author estimated differences between WIC and control groups in weight, assuming lifelong WIC participation. (Children that were certified for WIC because they were overweight were excluded from all analyses.) The results were controlled for whether the child was low birthweight or premature, and several other factors, if the relationship of the outcome with the factor was $F > 1.0$ in regression analysis.

Heimendinger (1981) then compared the difference between predicted growth (using age, sex, and size and weight at program entry to predict growth) with actual growth, among all infants and children who received postnatal WIC benefits (n=914). Prenatal WIC benefits were not taken into account. The predicted values were derived from age- and sex-specific NCHS standards for length, weight, and weight for length and were said to be corrected for regression to the mean. The results were presented as standard units (Z scores) and could not be translated into actual units from the data presented. While the author asserted that the changes over time in growth were not due to regression to the mean, this was by no means obvious. Low weight, or height, or weight for height were likely to have been recruitment criteria, and the population thus skewed to low values. Predicted later values would also be skewed to low values, since the prediction was based on the initial value. The only significant (positive) association with WIC for all three measures was at the first or second

Table II-A-12 (continued)

Control group	
Number	--
Treatment	NCHS standards
Results	Estimated differences from predicted values in length, weight, and weight for height (all in standard units, i.e, Z scores)[b] associated with varying duration of WIC benefits.

	Time since entry into program (months)				
	3	6	9	12	18
Length	.179**	.003	.035	-.057	-.286*
Log weight	.362***	.106	.096	.050	.197
Weight for length	.290***	.016	.061	.084	.090

Comment

- Comparison with NCHS standards omitted initially overweight children from analysis. Duration of WIC possibly associated with duration/severity of nutritional risk. The results are consistent with under-correction for regression to the mean.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a] Controlled for ethnicity, neighborhood, whether low birthweight/premature, Medicaid, number of illness visits/year, if F value > 1.0 in regression equation. Significance of differences not calculable from data presented. All WIC children certified for overweight excluded from analysis.

[b] Predicted from age, sex, and measurement at entry into program based on NCHS age and sex specific standards; children classified as overweight at first visit omitted.

Table II-A-12

Heimendinger (1981)

Population studied	All infants and children (active and inactive) registered at 3 sites from 2 Boston WIC programs with $\geq$ 2 sets of measurements by 18 months of age and from 2 health clinics serving the same area.
Assignment method/ research design	Retrospective analysis of WIC and clinic records.
Study group	
Number	476
Treatment	WIC: Prenatal and postnatal
Number	438
Treatment	WIC: Postnatal only
Control group	
Number	1,098
Treatment	Public clinic patients
Results	Prenatal WIC (n=466) associated with a 60 g increase in birthweight ($p < 0.05$), controlling for whether the infant was low birthweight, mothers' age, neighborhood, birth order, Medicaid and ethnicity.
	Estimated difference in weight (g) between WIC and control children assuming WIC children on program throughout their lives.[a]

	Age (months)				
	3	6	9	12	18
WIC					
Pre- and postnatal					
Boys	34	111	124	64	124
Girls	32	109	126	65	133
Postnatal only					
Boys	-109	379	124	289	523
Girls	-106	372	126	293	555

Comment

- Whether the child was low birthweight was controlled in birthweight analysis. The effect of this over control is probably to underestimate the relationship of WIC to birthweight. Results prone to selection bias: low birthweight may have led to postnatal WIC recruitment. Controls almost all on Medicaid and had significantly lower birthweight (63 g*) than combined pre- and postnatal WIC recipients.

(continued)

Table II-A-13

Hicks et al. (1982)

Population studied	21 sibling pairs in rural Louisiana.
Assignment method/ research design	Cross-sectional study comparing younger (index) sibling with prenatal WIC exposure to older sibling not recruited into WIC until after 1 year of age.
Study group	
Number	21
Treatment	Younger siblings (avg. age: 75.9 months) (WIC begun *in utero*)
Control group	
Number	21
Treatment	Older siblings (avg. age: 106.0 months) (WIC begun >1 year of age)

Results

	Cases	Controls	
WISC-R IQ			
Verbal	89.9	76.0	***
Performance	85.1	74.8	**
Full scale	86.4	73.4	***
Grade point average			
1st year	2.6	1.7	***
Overall	2.6	2.1	*

Growth not significantly affected other than lower percentage of visits at which height for age was deviant among cases ($p = 0.042$).

Comment

- Assessor not blind to whether child was index case or control. Differences attenuated after controlling for age; treatment outcome explicable by deteriorating performance with age. Older siblings stated to have "met nutritional risk criteria such as history of anemia or low weight for height in the case of children..." such that they may have been preselected to be at greater risk than younger siblings, which was consistent with significantly higher rate of visits with height < 10th percentile among older siblings.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

II-A-13. Hicks, L., R. A. Langham, and J. Takenaka. 1982. "Cognitive and health measures following early nutritional supplementation: A sibling study." Amer. J. Public Health 72(10):1110-1118.

Hicks et al. (1982) studied 21 school age sibling pairs from rural Louisiana parishes. The older (control) sibling was recruited into the WIC program after the first birthday, while the younger (index) sibling was in utero when the mother began in the WIC program. Subjects were, on average, 75.9 months of age, and controls, 106 months of age. Dramatic differences were observed in the cognitive function of the older and younger siblings. These results are subject to several uncertainties. For instance, the assessor was not blind to whether the child was a subject or control (other than for grade point average), and the authors stated that the elder siblings all entered the program because of nutritional risk criteria, which included anemia (most frequently), low height, or low weight for height. If this was true, it might have led to selection bias, consistent with the significantly greater frequency with which older siblings were judged to be under the 10th percentile for height. (The authors later stated [Hicks et al., 1983] that the older siblings were not recruited because of such nutritional risk criteria, but only because of low income.) In addition, the differences ascribed to nutritional supplementation were much greater than for any other study of this issue (Larimor and Pollitt, 1982).

The results of this study are of interest but must await confirmation with a study design which addresses these potential biases. (See commentary by Rush [1982, 1983], Pollitt and Lorimor [1983] and response by Hicks et al. [1983].)

The authors also related the numbers of WIC vouchers cashed with birthweight, but this analysis was possibly confounded by duration of gestation (the longer the pregnancy, the more chance to cash vouchers) and also possibly biased by differences in behavioral characteristics of early and late registrants for care and for WIC benefits. The seeking of early care is usually an index of lower risk as, in general, is compliance with any health regimen.

II-A-14. Kennedy, E. T., S. Gershoff, R. Reed, and J. E. Austin. 1982a. "Evaluation of the effect of WIC supplemental feeding on birth weight." J. Amer. Dietetic Assoc. 80(3):220-227.

Kennedy, E. T., and S. Gershoff. 1982b. "Effect of WIC supplemental feeding on hemoglobin and hematocrit of prenatal patients." J. Amer. Dietetic Assoc. 80(3):227-230.

Kennedy et al. (1982a,b) studied 910 women enrolled in WIC and 418 controls at 9 sites in Massachusetts from January 1973 to February 1978. There was one WIC clinic and one non-WIC clinic in each of four geographic areas (the presence of the ninth site in the study is unexplained). Three of the areas were urban and one rural. There were 897 WIC women and 400 controls with liveborn infants for whom birthweight was known. There was little description of the control women and whether they were comparable to cases (e.g., racial composition of the groups was not presented). What data are available suggest that the controls were at higher risk than WIC recipients. From the data presented, it was calculated that 42 percent of WIC recipients had income above 195 percent of poverty level (the qualification level for WIC) versus 37 percent of controls, although, by definition, none of the WIC recipients should have been above this level. A past prematurity rate was calculated for WIC multiparae of 3.9 percent versus 7.3 percent for multiparous control women, and a 7.7 percent rate of past low birthweight in the WIC group versus 9.5 percent for controls. In addition, for the subset of women for whom hematologic values were available, the initial values for controls were lower than for cases, although not significantly so. The most powerful evidence that the groups were not comparable was that the raw difference in birthweight of 122 grams was more than halved, to 60 grams, when controlled for selected differences in social and biologic characteristics between the two groups. Unfortunately, no data were presented to distinguish the effects of controlling the social versus the biologic variables. Some of the difference in biologic variables could have been changes that were mediating effects of WIC, such as weight gain. In any case, the limited data that were presented suggest that the groups were not initially comparable and that comparisons in outcome were likely, thus, to have been influenced.

The analysis assumed that the subgroup of women for whom hematologic data were available (148 of the 910 cases and 84 of the 418 controls) were not assayed for selective reasons, which may or may not have been the case. In comparing final levels of hemoglobin and hematocrit (which were significantly higher among WIC recipients than controls), the lower initial levels of controls were not taken into account, either by analyzing change scores or by adjusting for initial level.

This study is tantalizing because it is probable that there were effects of the WIC program, but without better description of the population, caution is appropriate before accepting that differences between cases and controls were in fact due to WIC.

Table II-A-14 (continued)

Study group	Hemoglobin and hematocrit:
Number	148
Treatment	Subset of prenatal WIC recipients with available data.
Control group	
Number	84
Treatment	Subset of controls with available data.

Results

	WIC			Controls		
Total group	Initial	Final	Diff.	Initial	Final	Diff.
Hgb (g%)	12.4	12.6***	0.2	11.9	11.7***	-0.2
Hct (%)	35.8	36.7***	0.9	35.6	35.1***	-0.5
Anemic only						
Hgb (g%)	10.9	12.1*	1.2	10.8	11.5*	0.7
Hct (%)	31.9	35.7	3.8	32.2	34.8	2.6

Comment

- Controls had lower initial Hgb and Hct values than cases, suggesting that they were at higher initial risk than cases. Initial disparity not taken into account in analysis.

*$p < 0.05$.
***$p < 0.001$.

Table II-A-14

Kennedy et al. (1982a,b)

Population studied	Pregnant women at 9 sites in Massachusetts, January 1973-February 1978 (1 WIC site and 1 non-WIC site in 3 urban areas and 1 rural area; 9th site unexplained).
Assignment method/ research design	Retrospective review of medical and nutrition records.
Study group	Birthweight:
Number	910
Treatment	Prenatal WIC recipients
Number	897--with recorded birthweight
Treatment	
Control group	
Number	
Treatment	"C1": Wait listed for WIC during pregnancy <u>or</u> certified postpartum (218 with birthweight)
Number	
Treatment	"C2": Women from non-WIC sites (182 with birthweight)
Number	Total: 418
Results	

	WIC	Controls C1	Controls C2	Total
Birthweight (g)	3,264	3,124	3,164	3,142
Difference from WIC	-	140	100	122***
Difference from WIC after controlling for social and biological differences	-	NA	NA	60*
% Birthweight <2,500 g	6.0	10.1	7.2	8.8*

Comment

- Cases and controls said to be comparable, but data to judge comparability were very limited (for instance, racial composition of study groups not reported). In fact 42% of cases had income >195% poverty level vs. 37% of controls. Cases had a past rate of preterm deliveries of 3.9% vs. 7.3% for control, and a 7.7% rate of past low birth weight vs. 9.5% for controls.

- After controlling for social and biological differences between study and control groups, birthweight difference halved, implying either (a) great initial differences between cases and controls, or (b) WIC effects mediated by changes in these variables, or (c) some contribution of both (a) and (b). Analysis by number of vouchers cashed confounded by duration of gestation.

(continued)

effect of the WIC program. In order to interpret the results of this study, it would be essential to know the outcome of the 353 women who were terminated from the WIC program. The rate of birthweight under 1,500 grams among WIC clients was less than half that of controls and may have also been due, in part, to the exclusion of terminated women from analysis.

On the other hand, on average, controls were probably not at as great a risk of poor health as were WIC recipients, given that the WIC program aggressively sought out low-income women at high nutritional and health risk, and neither income nor health and nutritional status could be matched. Thus, the observed mean birthweight difference between cases and controls of 21 grams may be an underestimate.

The effects ascribed to duration of WIC benefits are confounded by duration of gestation. Women with longer duration of gestation had greater opportunity for longer duration of treatment. With such bias, one would expect those with short treatment to have lower birthweights than their matched controls and those with longer durations of treatment to have higher birthweights than matched controls. This is what was found: relationships with duration of treatment cannot be interpreted as treatment effects without first controlling for duration of gestation in analysis.

II-A-15. Kotelchuck, M., J. B. Schwartz, M. Anderka, and K. Finison. 1981. "Massachusetts Special Supplemental Food Program for Women, Infants and Children (WIC) evaluation project: Final report." Massachusetts Department of Public Health, Boston.

Kotelchuck, M., J. B. Schwartz, M. Anderka, K. Finison. 1984. "WIC participation and pregnancy outcomes: Massachusetts Statewide Evaluation Project." Massachusetts Department of Public Health, Boston (to be published in the Amer. J. Public Health, October 1984).

Kotelchuck et al. (1981) compared the outcome of pregnancy of 4,126 WIC recipients in 1978 in Massachusetts to that of women who had not been enrolled in WIC, matched on several characteristics from their children's birth certificates. Controls were matched to WIC recipients on age, race, parity, marital status, area of residence (urban, suburban, or rural), and years of education.

Initially the investigators had identified 4,898 WIC participants but excluded 494 from further study, of whom 353 were excluded because they were "terminated" from the program. However, some of those categorized as terminated were likely to have been so because of adverse pregnancy outcome. The reasons for termination included noncooperation, noncashing of vouchers, and, according to the Massachusetts WIC program, not returning twice to pick up WIC vouchers. Thus, one of the possible reasons for program termination was that the woman might have delivered prematurely after having been recruited into the program but before returning to pick up vouchers for a second time. Thus, prematurity (with consequent neonatal death) might have led to program termination. In addition, the 353 included an unknown number of women who were truly noncooperators. Noncooperators are generally at higher risk of poor health than those who cooperate with programs, independent of any program content or effect. While such women were excluded from the study group, there was no way of excluding comparable women from the control group because there was no way to identify such (latent) characteristics. The control group, thus, is likely to include a small group of very premature deliverers and a larger group of noncooperators that had not been excluded from the case group. This difference in selection of cases and controls might have contributed to the major difference in outcome reported between WIC recipients and controls.

Among the 4,126 cases, there were only 12 neonatal deaths, a rate of 2.91 per thousand; in the 4,126 controls, there were 35 neonatal deaths, a rate of 8.48 per thousand. A neonatal death rate in 1978 of under three per thousand among a low-income group, with many minority women and at high medical and nutritional risk, is extremely low, lower than among the most privileged populations in the world at that time. In this relatively impoverished group, the expected rate might have been three times as high. Thus, the low rate may have been an artifact of study design rather than an

II-A-16. Kotelchuck, M., M. Anderka, L. J. Stern, M. Hudson, and L. Graham-Mero. 1982. "Massachusetts Special Supplemental Food Program for Women, Infants, and Children (WIC) followup study: Final report." Massachusetts Department of Public Health, Boston.

In a subsequent study, Kotelchuck et al. (1982) linked the record of the immediate prior birth for both cases and controls to the birth studied in their evaluation of WIC in Massachusetts in 1978 (Kotelchuck et al., 1981). Thus, change in birth outcome was contrasted for WIC recipients and controls. The authors were able to link 1,309 (of 4,126) pairs of women (both case and control) to past birth records, of whom 1,021 pairs were judged "very secure"; i.e., unlikely to have participated in WIC during the prior pregnancy. The other 288 women had prior births in WIC areas with poor or nonexistent participation records at the time of the prior birth. Less than half of the sample of matched pairs had gestational age information on all four births.

There was an interpregnancy increase 28 grams greater in the WIC than in the control group (n.s.) and significantly lower proportions of low birthweight infants (1.7 percent) and very low birthweight infants (1.1 percent) among WIC recipients. The rate of very low birthweight infants (<1500g) for WIC births was implausibly low (0.16 percent versus a national rate of about 1 percent). The number of neonatal deaths decreased from 11 to 5 in the WIC group and remained stable at 7 among controls, a result approaching statistical significance ($p = 0.07$). However, there is reason to believe that WIC women whose infants died in the neonatal period were systematically excluded from the study sample WIC women. The very low rates of very low birthweight and the rarity of neonatal death again suggest that these results are confounded by the exclusion of terminated WIC recipients (see comments above on the initial study of Kotelchuck et al. [1981]). The authors also reported a significant decrease in preterm birth and in the frequency of inadequate prenatal care.

Women who participated in WIC for at least two trimesters had better pregnancy outcome. These analyses are likely confounded by duration of gestation; longer gestation may have led to longer duration of WIC participation.

It is asserted that the comparison of two successive pregnancies of the same woman allows for a "powerful" evaluation of WIC. However, the criteria for determining eligibility for WIC benefit include poor obstetric history. Better outcome across time could thus be, in part, a function of regression to the mean. If women who had previous low birthweight infants were thus more likely to have been preferentially selected for WIC benefits, the weight of subsequent infants would then tend to regress to levels more typical for the population from which they were drawn. The greater the extent to which women were recruited into WIC based on prior poor obstetric history, the greater the potential effect of regression to

Table II-A-15

Kotelchuck et al. (1981)

Population studied	Outcome for all pregnant WIC recipients, Massachusetts, 1978, compared to matched controls.
Assignment method/ research design	Retrospective analysis of data from WIC records and linked birth certificates; matched control identified from birth certificate file, and matched on age, race, parity, education (years), marital status, and area (urban, suburban, rural).
Study group	
Number	4,898; 494 excluded (353 because of termination from program); 278 unlinked/unmatched; 4,126 linked to birth certificate and matched.
Treatment	WIC recipients
Control group	
Number	4,126
Treatment	None

Results

	WIC	Control	Diff.
Gestation (weeks)	4.0	39.7	.3***
% <37	5.8	6.8	-1.0
% SGA	4.7	5.0	-.3
Birthweight (g)	3,281	3,260	21
% <1,500 g	.48	1.04	-.56**
% 1,501 - 2,000 g	1.58	1.77	-.19
% 2,001 - 2,500 g	4.80	5.91	-1.11*
% <2,500 g	6.86	8.72	-1.86**
Neonatal deaths/1,000	2.91	8.48	-5.57**

Comment

- Those terminated from program (n=353) likely include disproportionate numbers of very preterm deliveries, with infants dying in the neonatal period (preterm delivery could preclude revisit and mother would have been dropped from program). Neonatal death rate of <3/1,000 is extremely unlikely for this population in 1978, as was the highly significant deficit in birthweights <1,500 g.

- Extensive analyses by duration of treatment (not presented here) confounded by duration of gestation (see text). Controls unlikely to have been at as high risk as WIC recipients, which would tend to give low estimates of WIC effect on mean birthweight.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Table II-A-16

Kotelchuck et al. (1982, 1983)

Population studied	Same population as in Kotelchuck et al. (1981)
Assignment method/ research design	Births to pregnant WIC participants and controls linked to birth certificates from last prior birth.
Study group	
Number	1,309
Treatment	1978 WIC recipients
Number	1,021
Treatment	"Very secure", i.e., unlikely to have received WIC benefits in prior pregnancy.
Control group	
Number	1,309
Treatment	Controls
Number	1,021
Treatment	"Very secure"

Results

	WIC			Control			Diff. WIC -
	Index	Previous	Diff.	Index	Previous	Diff.	Diff. control
$\bar{X}$ Birthweight (g)	3,297	3,228	69	3,295	3,254	41	28
% LBW	7.2	7.3	-.1	8.3	6.7	+1.6	-1.7*
% Preterm	5.5	6.8	-1.3	6.6	5.3	+1.3	-2.6*
% Small for gestational age	5.9	5.4	+.5	4.7	3.1	+1.6	-1.1
Neonatal deaths/1,000 livebirths	3.8	8.4	-4.6	5.3	5.3	-	-4.6
% No or inadequate care	4.0	7.1	-3.1	7.9	8.0	-0.1	-3.0*

Similar results for secure sample. No differences in gestational age, complications of pregnancy, mean number of prenatal visits and mean month prenatal care began. Results adjusted for sex.

Comment

- Likely that some preterm births were excluded from study pregnancies, and that controls were at lower general risk than cases. If poor postobstetric history was a criterion for WIC program recruitment, results are in part explicable by regression to the mean.

* $p < 0.02$.

the mean. If women who had previous low birthweight infants were thus more likely to have been preferentially selected for WIC benefits, the weight of subsequent infants would then tend to regress to levels more typical for the population from which they were drawn. The greater the extent to which women were recruited into WIC based on prior poor obstetric history, the greater the potential effect of regression to the mean. Such selection is suggested by the poorer prior birth outcomes among the WIC group.

In addition, the same workers included a one-page addendum in which they compared the proportion of infants with birthweight under 5½ pounds for the years 1979 through 1981 for mothers who had 3 months or more of WIC benefits, fewer than 3 months of benefits, or enrolled in the program postpartum. The postpartum enrollees received neither WIC services nor any prenatal medical attention from a State health unit. Thus, these results were subject to confounding by duration of pregnancy (longer duration of benefits was, in part, a function of longer pregnancies). The results might have been in part a function of preterm delivery, in that postpartum enrollees who delivered very prematurely might have enrolled in WIC had they continued to carry their infants. Also, postpartum enrollees were probably selectively recruited into the WIC program because of low birthweight. Thus, while the rate of low birthweight was 12.7 percent among the postpartum enrollees, 11.7 percent among those enrolled in WIC 3 or fewer months and 7.6 percent among those enrolled for more than 3 months, the differences cannot be securely ascribed to the effect of the WIC program.

II-A-17. Langham, R. A., B. W. Dupree, E. H. Atkins, and P. E. Schilling. 1975. "Impact of the WIC program in Louisiana." Unpublished report. Louisiana State Health Department, New Orleans.

Langham et al. (1975) reviewed every third WIC record for infants and children enrolled in WIC programs in operation at least 15 months in 10 Louisiana parishes in 1974-75. Of the 1,465 children, 252 or 19 percent of the children never returned for certification or refused or were uninterested in the program. The proportion of children above the 90th percentile, below the 10th percentile, and between the 10th and 90th percentiles for height, weight for height, and hemoglobin or hematocrit were presented graphically. Although the data were amenable to longitudinal analysis, cross-sectional results were presented by visit (visits were separated by approximately 3 months) for all children for whom data were available at that visit. Thus, with each succeeding visit, there were fewer children available for analysis.

The results for infants under a year of age were confusing. Over the course of time, the proportion of children under the 10th percentile for height decreased, but in spite of dietary supplementation so did the proportion over the 90th percentile. Regression to the mean could not explain this decrease in longest infants, since the initial group would not have been selected to overrepresent long infants. There was no change in the proportion of children under the 10th percentile for weight from the second through fourth revisit and some decrease in the proportion of overly heavy infants. The hemoglobin/hematocrit values did not change much after the second visit. (Any change from first to second visit would be heavily influenced by regression to the mean.)

For children 1 to 4 years of age, the proportion under the 10th percentile for height decreased and the proportion over the 90th percentile increased as enrollment continued. There was little difference in weight for height among these older children. Decreases in anemia over time were again influenced by regression to the mean. If low hemoglobin and/or hematocrit were recruitment criteria, the initial population was skewed toward low values and at least part of any measured increase at the second visit (but less from the second visit onward) would be due to regression to the mean.

The small group of infants and children who had at least five visits were compared with children of the same age who had not had any WIC benefits. There were large differences in growth between these groups, but no data to judge their initial comparability were presented nor was there any adjustment for noncomparability. Since initial dropouts were at considerably higher risk than those who continued to participate in the WIC program, it is reasonable to assume that the small group who were in the program for five or more visits might not have otherwise been comparable to an unselected control population.

Table II-A-17 (continued)

Population studied	Women enrolled in WIC in Louisiana, 1979-1981
Assignment method/ research design	Retrospective review of WIC forms for every third participant.
Study group	<u><3 months</u> / <u>4+ months</u> 1,266 / 1713 (white) 3,496 / 5,252 (black) 4809, / 7,008 (total)
Control group	<u>Postpartum</u> 2,160 (white) 3,971 (black) 6,214 (total)
Results	% Birthweight <2,500 g (see below)
Comment	• WIC maternity patients Louisiana, 1979-81. Controls postpartum WIC recruits. Results confounded by duration of gestation, higher risk of postpartum recruits.

Results: % Birthweight <2,500 g

	Duration of WIC benefits (months) <3	4+	Total WIC	Postpartum recruits	Total
White	7.1	5.3	6.1***	9.8	7.6
Black	13.4	8.4	10.4***	14.3	11.6
Total	11.7	7.6	7.9***	12.7	10.4

*** $p < 0.001$.

Table II-A-17

Langham et al. (1975), (1981)

Population studied	Infants and children enrolled in WIC programs in 10 parishes in Louisiana, 1974-75.
Assignment method/ research design	Retrospective review of WIC forms for every third participant.
Study group	
Number	604
Treatment	Age: <1 year
Number	861
Treatment	Age: 1-4 year
Control group	
Number	None
Treatment	None
Results	Results presented as graphs; all differences therefore approximations: <u>Infants</u>: Height: Progressive decrease in % <10th percentile and >90th percentile for 4 visits (9 months on program). Weight for height: No change in % <10th percentile from 2nd to 4th visits, some decrease in % >90th percentile. Hemoglobin or hematocrit: Major change from visit one to two; little consistent change thereafter. <u>Children</u>: Height: Progressive decrease in % <10th percentile, increase in % >90 percentile. Weight for height: little change. Hemoglobin or hematocrit: Major change only between visits one or two.
Comment	• 253, or 19%, either did not return for recertification (227) or refused to participate or were uninterested in program (24). Dropouts had lower weights, heights, hemoglobin and hematocrit than participants. Cross-sectional analyses of longitudinal data: numbers assessed at each revisit greatly diminished. • Hemoglobin and hematocrit findings consistent with regression to the mean.

(continued)

Therefore, the tentative conclusion is that there was a marked excess of women predicted to have infants of high birthweight in the WIC group and a deficit of those predicted to have low birthweight and that these differences were not taken into account in the analysis. Indeed, among those predicted to have light babies, WIC recipients had significantly shorter gestation (0.9 week, $p < 0.001$) and infants 146 grams lighter than controls (n.s.). In the group predicted to have average birthweight, WIC recipients had infants that were 14 grams lighter than controls; but in the group predicted to have heaviest infants, where the authors had initially posited little or no WIC effect, the WIC group had infants 111 grams heavier than controls (n.s.). These results were thus in direct contradiction to initial hypotheses. However, the authors chose to conclude that there were positive effects of WIC on birthweight by combining all cases and controls (biasing their results strongly because of the maldistribution of cases and controls on predicted birthweight) and by controlling for gestation, thus removing the significant negative association of WIC with duration of gestation among the women predicted to have small babies.

Past work does not support the assumption that nutrition during pregnancy can act only on fetal growth and not on duration of gestation. While effects on gestation may be small, they are probably real (Kristal and Rush, 1984). Indeed, Edozien et al. (1976a, b; 1979) asserted in their evaluation of WIC that the greatest part of the relationship between WIC benefits and birthweight was mediated by about 5 days increase in duration of gestation, and results in the prenatal project suggested that the balanced protein/calorie complement exerted beneficial effect via longer duration of gestation (Rush et al., 1980a, b). In the cross-sectional study designs of Edozien et al. (1976a, b; 1979) and of Kotelchuck et al. (1981), in order to judge the effect of duration of treatment on outcome, it was obligatory to control for gestation, but there was no such necessity in this prospective trial: to control for gestation was not an analytical necessity, but rather an implicit assumption that WIC effects would be mediated entirely on fetal growth and not through duration of gestation.

The inclusion in the study of women in the group whose infants were predicted to have average birthweight is confusing. They were not part of the initial study design, and it is not clearly specified that they were allocated randomly. Finally, the study groups were probably too small to yield secure results, one way or the other.

II-A-18. Metcoff, J., P. Costiloe, W. Crosby, H. Sandstead, C. E. Bodwell, and E. Kennedy. 1982. "Nutrition in pregnancy ("NIP") final report (USDA)." Report to the Food and Nutrition Service, USDA. University of Oklahoma Health Sciences Center, Oklahoma City.

Metcoff and colleagues (1982) performed a randomized trial of assignment to WIC among women enrolling for prenatal care at the Oklahoma University Health Sciences Center. They applied a complex formula, derived from multiple regression analysis, to predict at the time of recruitment the likely birthweight of the infant. The reported screening formula (see the authors' Table 2) included terms for week of gestation at initiation of care, race, maternal height, prepregnant weight, weight gain at 21 weeks gestation, smoking, fundal height at recruitment, and pregnancy number. Inexplicably, the screening formula was also reported to include duration of gestation of the index pregnancy and the sex of the infant, neither of which would be known until delivery. Thus, how this screening equation was applied during gestation, when it required data unknown until delivery, is obscure.

Some 900 women were expected to be eligible for WIC. The decision was made that those in the two extreme terciles (i.e., those predicted to have infants of lowest and of highest birthweight) would be randomly allocated to WIC or control status, with twice as many WIC recipients as controls. Those predicted to have infants of average birthweight would be given WIC benefits as they were available. The authors stated that one of their hypotheses was that "WIC intervention will most benefit those at highest risk, i.e., the mothers likely to have the smallest babies, but not the mothers likely to have large babies." (Indeed, in order to estimate needed sample size, the authors predicated that WIC benefits would lead to a 400-gram increase in birthweight among infants predicted to have lowest birthweights. Such a large increment in birthweight runs counter to past experience [Rush, 1982].) However, in analysis this hypothesis was not retained, and the investigators combined all WIC recipients, whatever the predicted birthweight of their infants, and similarly combined all controls. This decision had dramatic effects on reported results, since among those predicted to have small babies, there were fewer than twice as many WIC recipients as controls (63 vs. 37), while among those predicted to have large babies, there were almost three times as many WIC recipients as controls (92 vs. 34). There were also 83 WIC recipients and 101 controls among those predicted to have average size babies. In their multivariate analysis, the authors did not take into account this marked bias created by the maldistribution between cases and controls on predicted birthweight. For instance, in judging the overall effect on birthweight (see the authors' Table 9) the only recruitment criterion used for adjustment purposes was smoking. They also controlled for gestational age of the index pregnancy, sex, number of prenatal visits (thus precluding any judgment on mediation of WIC effects by the extent of prenatal care), interval since last pregnancy and history of past low birthweight delivery, which were not included in the risk equation.

Table II-A-18 (continued)

Results (continued)

	Predicted birthweight <3,600 g WIC	Controls	Diff.	Total WIC	Controls
# Cigarettes/day	2.9	4.8			
Entry weight (kg)	78.7	81.6	-2.9		
Weight gain/ week (kg)[a]	.50	.53			
Abortions (%)				1.08	1.03
Stillbirths (T)				.72	.51
Duration of gestation (weeks)	40.2	40.1	.1		
Birthweight (g)	3,507	3,396	111	3,292	3,296
% <2,500 g				8.7	6.9
	(92)	(34)			

Comment

- Initial hypothesis: "WIC intervention will most benefit...mothers likely to have smallest babies but not mothers likely to have large babies." This hypothesis was not retained in analysis, in which all women assigned to WIC and all controls were combined. Only those predicted to have small (<3,000 g) or large (>3,600 g) babies were to be randomized, but 83 WIC and 101 controls of expected average birthweight were included in trial.

- Results not adjusted for excess of WIC recipients among those predicted to have high birthweight.

- Authors adjusted both for duration of gestation and number of prenatal visits, thus removing any effect of WIC mediated by increased frequency of prenatal visits, or of WIC on duration of gestation. With these analytic assumptions, and without controlling for excess of WIC recipients in group predicted to have high birthweight, the WIC group was reported to have birthweights 91 g greater than controls.

**p < 0.01.
***p < 0.001.
( ) = n.

[a]Data not available for 26% study population.

Table II-A-18

Metcoff et al. (1982)

Population studied

Women delivering at Oklahoma University Health Science Center meeting both WIC income and other risk criteria (estimated n=900 of 3,000 total deliveries/year).

Assignment method/ research design

Text states this to have been a randomized controlled trial of WIC benefits among lowest and highest <u>terciles</u> of the 900 eligible women based on predicted birthweight (results appear to be for <u>quartiles</u>), with two-thirds assigned WIC, one-third controls; middle tercile said to be assigned to WIC if places available; some of them also randomly allocated to WIC or control status.

Study group

Number: 63; 83; 92; total 238

Treatment: WIC: predicted birthweight <3,000 g; 3,000-3,600 g; >3,600 g

Control group

Number: 37; 101; 34; total 172

Treatment: Controls: predicted birthweight <3,000 g; 3,000-3,600 g; >3,600 g

Results

	Predicted birthweight <3,000 g			Predicted birthweight 3,000-3,600 g		
	WIC	Controls	Diff.	WIC	Controls	Diff.
# Cigarettes/day	14.8	11.6		8.4	8.6	
Entry weight (kg)	55.9	55.0	.9	69.2	64.0	5.2**
Weight gain/ week (kg)[a]	.52	.43		.53	.49	
Abortions (%)						
Stillbirths (%)						
Duration of gestation (weeks)	39.2	40.3	-.9***	39.8	40.0	-.2
Birthweight (g)	2,928	3,074	-146	3,329	3,343	-14
% <2,500 g						
	(63)	(37)		(83)	(101)	

(continued)

Table II-A-19

Nutt et al. (1981)

Population studied	Women delivering in a large maternity hospital in Columbus, Ohio, from early 1978 to early 1979.
Assignment method/ research design	Retrospective study of medical and WIC records; cases and controls said to be "matched" on age, parity, race, educational attainment, method of payment and other factors, but racial disparity inconsistent with "matching."
Study group	
Number	104
Treatment	WIC
Control group	
Number	104
Treatment	Routine prenatal care

Results

	Birthweight (g)[a]		
	WIC	Non-WIC	Difference
Public assistance	3,197 (48)	2,751 (29)	446***
Self-pay/insurance	3,236 (56)	3,344 (75)	-108

Overall WIC/non-WIC difference = 72 g ($p = .004$) controlled for race, duration of prenatal care and method of payment.

Comment

- While WIC and control groups were said to be matched on race, 23% of controls vs. 51% of WIC group were nonwhite ($p < 0.0001$) and 29% of controls and 46% of the WIC group were receiving public assistance ($p < 0.01$).
- There were 8 more girls in the control than WIC group. Sex was not controlled in analysis and would account for about 12 g of WIC/non-WIC difference.

*** $p < 0.001$.

( ) = n.

[a] Controlled for race and months of prenatal care.

II-A-19. Nutt, P. C., M. Wheeler, and R. A. Wheeler. 1981. "Social program evaluation revisited: The WIC program." The Ohio State University, American Institute of Decision Sciences.

Nutt et al. (1981) compared 104 WIC participants who were delivered at a large maternity hospital in Columbus, Ohio, with 104 controls said to be "matched" on mother's age, race, parity, and duration of prenatal care; parental years of schooling; newborn sex; method of payment (Medicaid, welfare, insurance, self-pay); whether delivery was spontaneous; whether delivery was vaginal; and type of analgesia and anesthesia. There were, however, marked disparities between cases and controls for several of these factors. For instance, there were 53 nonwhites in the WIC group, but only 24 in the control group ($p < 0.0001$) and 48 women on public assistance in the WIC group and 29 in the control group ($p < 0.01$).

Outcome measures were birthweight, Apgar score, use of resuscitation, and the presence of congenital abnormalities. Duration of WIC participation was one of the independent variables. Data were gathered retrospectively from hospital prenatal and delivery charts and WIC enrollment records.

Linear regression was used to adjust for differences between the WIC and control groups in race and months of prenatal care. Welfare recipients were more likely than those with medical insurance or who paid their own costs to receive WIC benefits. Race, prenatal care, and method of payment (a proxy for income) were strongly associated with birthweight. After controlling for race, duration of prenatal care, and method of payment, WIC mothers had newborns with mean birthweights 72 grams greater than infants of non-WIC mothers ($p = 0.004$). The excess of eight girls in the control group could account for about 12 grams of this difference. Among mothers on public assistance, with control for race and months of prenatal care, WIC participation was associated with a 446-gram higher mean birthweight than those not on WIC (3,197 g vs. 2,751 g, $p < 0.001$).

and 35.4 percent for controls, n.s.). Of those immunized, WIC infants received their second DPT and OPV immunizations significantly later than controls (approximately 2 weeks). There were no differences in age at third DPT immunization, but controls were substantially older than WIC infants at the time of third OPV immunization. This difference, however, was ascribed to different immunization schedules between WIC and non-WIC counties. Thus, administrative differences probably accounted for the significantly higher rates of completion of DPT immunization by controls. (Data for immunization were missing for 45 percent of WIC recipients, but for fewer than 1 percent of controls.)

II-A-20. Paige, D. 1983. "Evaluation of the WIC Program in infants on the Eastern Shore of Maryland." Johns Hopkins University, Department of Maternal and Child Health, Baltimore, Maryland.

Paige (1983) reviewed records of all infants participating in the WIC program in three counties in the Eastern Shore of Maryland in 1979 and 1980 and of all infants meeting WIC income and nutritional eligibility criteria in two geographically contiguous counties without WIC programs during the same years. Only infants enrolled prior to 3 months of age, for a minimum of 10 of their first 12 months of life, and with at least three well-care visits during the year were included in the study. Infant feeding practices, morbidity, growth, hematology, and immunization were assessed. There were fewer males in the WIC group (47 vs. 54 percent among controls) and fewer blacks (55 vs. 60 percent in the control group). Other characteristics such as maternal and paternal age and education, gravidity, number of living children, number of prenatal visits by trimester, type of site of prenatal care, mode of delivery, and duration of gestation were comparable, though more mothers of non-WIC infants were single (46 vs. 38 percent, n.s.) and below 185 percent poverty level (60 vs. 21 percent, $p < 0.001$) than mothers of WIC infants. Birthweight was lower among those who received postnatal WIC vs. controls (WIC, 3,169 g, vs. controls, 3,234 g, n.s.). It was unclear whether, or how many, postnatal WIC recipients also received prenatal benefits.

Age at first postnatal clinic visit was substantially different, so data for the first visit are omitted from the table. Ages at second and third visits were comparable.

Infant feeding practices were related to prenatal WIC benefits. Prenatal WIC recipients were less likely to either breastfeed or use whole cow's milk. The increased use of soy-based formula by controls may be associated with, but cannot fully be explained by, racial differences between WIC recipients and controls (more blacks might have had lactose intolerance, leading to use of soy-based formula).

Controls had a higher incidence of acute illnesses (upper respiratory infections, dermatologic conditions, gastro-intestinal problems, and other minor infections) at their first two visits, but virtually identical rates by the third visit. WIC recipients weighed less and were shorter at first visit, even after adjustment by analysis of variance for age and sex. By the third visit, white WIC infants were heavier (0.24 kg, $p = 0.28$) and longer (0.54 cm, $p = 0.39$) than white controls, while black WIC infants remained lighter (0.25 kg, $p = 0.21$) and shorter (0.74 cm, $p = 0.14$) than controls. As WIC recipients were 65.8 grams lighter at birth (and most likely shorter), analyses unadjusted for size at birth probably underestimate the beneficial effect of postnatal WIC participation on growth. While WIC infants and controls had identical weight-to-length ratios at second and third visits, WIC recipients had slightly larger head circumferences (0.2 cm, n.s.) at the third visit. WIC infants had slightly lower hematocrits at second and third visits (34.5 percent for WIC participants

II-A-21. Pelto, J. M. 1982. "Results of a nutrition intervention program: The WIC program in Alaska." Alaska Medicine 24:14-17.

Pelto (1982) assessed the WIC program of two urban clinics in Alaska by reviewing medical charts of participants before and at least 6 months after certification for WIC. In the Anchorage clinic, 219 participants had an increase in measured hemoglobin values from 10.7 g/dL at certification to 11.6 g/dL 6 months later. Women, infants, and children were not analyzed separately and no statistical tests were presented.

The increase in observed values was most likely confounded by regression to the mean, as well as by age. Except in early infancy, hemoglobin concentration, on average, increases in early childhood. Some of the reported increase might thus reflect normal increase with age. Similarly, maternal hemoglobin concentration increases after delivery. Since some of the 6-month recertifications for pregnant women occurred postpartum, some of any increase in maternal hemoglobin was in part a reflection of normal physiologic change.

Hemoglobin values had been recorded both before and during WIC intervention on 25 of 27 charts that were reviewed in Juneau for children 1 to 5 years of age. There was a mean increase in hemoglobin from 10.9 to 12.3 g/dL.

The author reported decreased incidence of low birthweight concurrent with the diffusion of the WIC program, especially in the North Slope region, where the rate dropped from 11.1 percent in 1974 when WIC began to 8.6 percent in 1978. During the same period, the rate fell statewide from 5.9 to 5.2 percent. However, from the graphic display, the decline appears to have begun before the inception of WIC: in 1972, the rate appeared to be approximately 13 percent in the North Slope region and 6.5 percent statewide. (The year of WIC inception is not precisely identifiable on the graph, since each year was represented as a running average of 3 years.) The analysis did not relate varying numbers of women served by WIC to variation in change in birthweight or account for any other possible reasons for changes in birthweight, such as changing demographic composition or socioeconomic status of the North Slope population. These limitations are such that the relationship between WIC benefits and either hematologic indices or perinatal outcome cannot be attributed securely to the WIC program.

Table II-A-20

Paige (1983)

Population studied

All infants participating in WIC in three counties of the Eastern Shore of Maryland and all infants meeting WIC eligibility and participation criteria enrolled in county health department clinics in two geographically contiguous counties not participating in WIC. All enrolled prior to 3 months of age, for a minimum of 10 out of the infant's first 12 months of life, with at least three visits during the year. Fiscal years 1979-80.

Assignment method/ research design

Historical prospective analysis from available health records for all eligible infants.

Study group

Number: 150
Treatment: Prenatal WIC

Number: 148
Treatment: Postnatal WIC

Control group

Number: 229
Treatment: No prenatal WIC

Number: 213
Treatment: No postnatal WIC

Results

Differences between WIC and control groups for several indices. Infant feeding by prenatal benefits; all other outcomes by postnatal benefits.

	Visit number 2		Visit number 3	
	WIC	Control	WIC	Control
Infant feeding				
% breastfeeding	.6	5.8*	.6	1.0
% on formula	62.0	60.0	23.0	16.0
% on whole cow's milk	.6	24.8***	44.5	79.2***
% soy-based formula	36.9	9.2***	32.1	3.4***
Growth				
Weight (kg)	7.8	7.9	9.8	9.9
Length (cm)	66.2	66.7	73.8	74.0
Weight/length	.12	.12	.13	.13
Head circumference (cm)	43.0	43.3	46.1	45.9
Hematocrit (%)	34.2	35.5	34.5	35.4
Immunization				
% completed DPT series	76.0	91.0***	74.0	93.0***
% completed OPV series	23.0	9.0***	88.0	100.0
Mean age (months)	6.38	6.20	11.76	11.60

Comment

- Age at first visit not comparable (WIC: 0.87 months; Control: 2.23 months), and results are therefore omitted. Results adjusted for age, race and sex are similar to unadjusted results. Data for immunization were missing for 45% of WIC recipients vs. <1% for controls.

*p < 0.05.
**p < 0.01.

Table II-A-21 (continued)

Population studied	WIC participants in clinics in Juneau and Anchorage, Alaska.
Assignment method/ research design	Incidence of low birth weight compared to vital statistics for Alaska.
Study group	
Number	All births in regions with WIC programs initiated between 1972 and 1979.
Treatment	--
Control group	
Number	All births in Alaska between 1972 and 1979.
Treatment	--
Results	

	% Birthweight <2,500 g, 1972-1979			
	1972	1974	1976	1979
Statewide	6.5	5.9	5.2	5.2
North Slope Region[a]	13.0	11.1	10.3	9.0

Comment	• Analysis did not relate numbers of women served by WIC to variation in birthweight by region nor account for other causes of changes in birthweight in North Slope Region such as changing socioeconomic or ethnic composition of region.

[a]WIC region with maximum drop.

Table II-A-21

Pelto (1982)

Population studied	WIC participants in clinics in Juneau and Anchorage, Alaska.
Assignment method/ research design	Retrospective review of charts before and at least 6 months after certification.
Study group	
Number	Anchorage: 219 (28 women, 127 infants, 64 children).
Treatment	WIC intervention. Certified for $\geq$6 m and met criteria for one of the 3 top WIC priorities.
Number	Juneau: 27 (children)
Treatment	--
Control group	
Number	None
Treatment	--
Results	

Mean hemoglobin (g/dl):	n	At certification	At recertification
Anchorage	219 (or 211)	10.7	11.6
Juneau	27	10.9	12.3

Comment

- Hemoglobin values confounded by regression to the mean, and probably by age.

- Exclusion of those not recertified probably depresses estimate of WIC effect by excluding those graduated from program. Also, those not returning might be behaviorally or socially different from those returning.

(continued)

Table II-A-22

Rye et al. (1978a)

Population studied	Pregnant women enrolled in WIC programs in 14 county and 9 tribal programs in Arizona, July 1976-March 1977.
Assignment method/ research design	Compared low birthweight rate of infants born to women receiving WIC benefits to State rate for 1975.
Study group	
Number	Livebirths: 1,360 (1976-77); unknown (1977-78)
Treatment	WIC
Number	"Over 13,000" (1976-77); 17,934 (1977-78)
Treatment	--
Control group	
Number	
Treatment	All births in State, 1977
Results	(% Birthweight <2,500 g)

	WIC	Statewide	
1976-77	5.4	6.3	(1977)
1977-78	6.6		

Comment	• Comparability of pregnant control group unexamined. Not controlled for high birthweight among American Indians.

(continued)

II-A-22. Rye, J., M. White, M. Majchrzak. 1978a. "Intervention outcomes in Arizona's WIC program, July 1976 through March 1977." Unpublished report. Pima County, Tucson, Arizona,

Rye et al. (1978a) reviewed health records of WIC participants from 1976 to 1977 and from 1977 to 1978 in Arizona. There were 1,360 livebirths to prenatal WIC participants in the first year and an unspecified number in the second. There were "over 13,000" infants and children participating from 1976 to 1977 and 17,934 from 1977 to 1978.

The rate of low birthweight among WIC participants was 5.4 percent from 1976 to 1977 and 6.3 percent from 1977 to 1978, versus 6.3 percent statewide in 1977. The authors point out that the WIC group was probably at higher risk than the statewide population. On the other hand, American Indian birthweights are high, especially given the short stature and social and economic deprivation of Indian mothers, and separate results for Indian participants and controls would therefore be helpful.

The dramatic decrease in abnormal hemoglobin, hematocrit, short stature, underweight, and overweight were confounded by regression to the mean and biased to the extent that abnormalities in these indices might have been used as recruitment criteria, or misreported in order to ensure program eligibility.

II-A-23. Schelzel, G., and M. A. Britton. 1978. "An assessment of the WIC program in Pennsylvania." Unpublished report. Pennsylvania Health Department.

Schelzel and Britton (1978) evaluated two WIC programs in Pennsylvania that began in 1974. Comparisons were between status at entry into the program and at recertification (generally after 6 months) for a random sample of 119 pregnant women, 49 infants, and 233 children, from 1974 to 1977.

Some results were implausible. Infant mortality for all past pregnancies was compared to that for the current pregnancy, during which women were enrolled in the WIC program. For the 64 women with less than 6 months of WIC benefits, past infant mortality was 106 per 1,000, but 16 per 1,000 for the current birth. For the 55 women with 6 or more months of WIC benefits, the past rate was 141 per 1,000, and zero in the current pregnancy. The pre-post comparison was most likely influenced by past adverse pregnancy outcome being a criterion for WIC eligibility; the observed decrease was probably, in part, a function of regression to the mean. The same caveat applies to the marked reduction of prematurity and immaturity (not defined).

Table II-A-22 (continued)

Population studied	Infants and children enrolled in WIC July 1976-March 1977, and 1977-78.
Assignment method/ research design	Infants and children: pre-post comparison for anemia, overweight, underweight, and short stature before and after WIC intervention, from health records.
Study group	
Number	--
Treatment	--
Control group	
Number	None
Treatment	--

Results

	Proportion of infants and children abnormal (%)			
	1976-77[a]		1977-78[b]	
	Initial[a]	After intervention	Initial	After intervention
Low hemoglobin or hematocrit	17.2	5.1	7.4	1.3
Short stature	18.0	7.8	13.6	6.3
Underweight	7.7	2.0	5.8	1.0
Overweight	19.7	9.5	14.2	7.0

Comment • All results confounded by regression to the mean.

[a]Assuming 13,000 screened.

[b]Assuming 17,934 screened.

II-A-24. Schramm, W. F. 1983. "WIC prenatal participation and its relationship to newborn Medicaid costs in Missouri: A cost/benefit analysis." Missouri Center for Health Statistics, Jefferson City, Missouri.

Schramm (1983) conducted a cost-benefit analysis of the WIC program among Medicaid recipients in Missouri in 1980, using the merged data for Missouri from the WIC program and vital statistics (birth, fetal, and infant death certificates; Stockbauer and Blount, 1983). Of 9,062 newborns with Medicaid coverage, 8,996 (99.3 percent) were matched to their birth records, but for 25 percent, no mothers' Medicaid records could be found. After exclusion of records with reported third party insurance coverage (n=407) and with total paid claims less than $100 (in order to eliminate records with incomplete costs, n=961), 7,628 births were available for analysis: 1,883 WIC recipients, and 5,745 Medicaid recipients presumably not enrolled in the WIC program. Since previous efforts to match WIC receipt with birth/fetal death records were successful for 93 percent, rather than 100 percent, of known WIC recipients, a small proportion of the unmatched Medicaid records was probably for pregnancies in which mothers were WIC beneficiaries.

In the WIC group, there were significantly more mothers under age 18 ($p < 0.05$), who were 15 percent or more underweight ($p < 0.05$), who were married ($p < 0.01$), and who lived in rural areas ($p < 0.01$). Comparisons between the WIC and non-WIC groups were directly standardized against the total study sample. There were no significant differences in the rate of preterm delivery; neonatal, postneonatal, and infant mortality; the frequency of pregnancy and labor complications; malformations; and mean length of hospital stay for either infant or mother. The reported death rates for infants of mothers on Medicaid were considered to be falsely low, since, if the infant died, the mother might not have applied for Medicaid for the child. While mean birthweight was only 6 grams greater among WIC recipients, the proportion with birthweight under 2,500 grams was 1.9 percent lower in the WIC group ($p < 0.05$).

The authors estimated that for each WIC dollar spent, 83 cents less was spent by Medicaid and 59 cents less spent from other sources. There were cost differences only for infant, but not maternal, care.

Savings were greatest for infants of low-risk, rather than high-risk, mothers: differences for high-risk mothers were not statistically significant. About one-fourth of the savings was secondary to the (nonsignificantly) shorter hospital stay of WIC infants (4.7 vs. 4.9 days). The remainder of the difference in cost was predicated to be secondary to the reduction in the number of low-birthweight infants, i.e., from the lower average daily hospital costs of about $15.00. Another possible explanation was that WIC recipients delivered in less expensive hospitals, consistent with their greater likelihood of rural residence. In order to judge whether the lower frequency of low birthweight accounted for the cost

Table II-A-23

Schelzel and Britton (1978)

Population studied	Participants in two Pennsylvania WIC programs, 1974-1977.
Assignment method/ research design	Status at entry into WIC compared with that at recertification.
Study group	
Number	119 pregnant women; 64 <6 months on WIC 55 $\geq$ 6 months on WIC; (49 infants, 233 children)
Treatment	--
Control group	
Number	None
Treatment	--

Results

	Entry into WIC	Later measure	Difference
Infants			
% <5th percentile for height	16.3	10.2	-6.1
% <5th percentile for weight	16.3	12.2	-4.1
% >95th percentile for weight	4.1	4.1	-
Children			
Abnormal hemoglobin hematocrit	24.0	7.7	-16.3
% <5th percentile for height	14.2	7.3	-6.9
% <5th percentile for weight	12.0	6.9	-5.1
% >95th percentile for weight	4.7	5.2	+0.5
Women[a]			
Infant deaths/1,000			
<6 months on WIC	106.4	16.1	-90.3
$\geq$6 months on WIC	141.3	0	-141.3
% premature[b] births			
<6 months on WIC	5.3	0	-5.3
$\geq$6 months on WIC	12.0	1.5	-10.5
% immature[b] births			
<6 months on WIC	12.8	1.6	-11.2
$\geq$6 months on WIC	18.5	1.5	-17.0

Comment

- No controls. Regression to the mean and possible bias towards low measures in order to ensure certification could account for some of the observed change over time.

[a]Comparison with all past pregnancies.

[b]Not defined.

II-A-25. Sharbaugh, C., C. Morris, and C. Mahan. 1977. "The North Central Florida WIC evaluation." Unpublished report. North Central Florida Maternity and Infant Care Project, Gainesville, Florida.

Sharbaugh et al. (1977) compared birth outcomes among North Central Florida Maternity and Infant Care Project (MIC) clients before (1970 to 1975) with the first 15 months after the institution of WIC programs (1975 to 1976). There were 6,944 women in the earlier period and 2,126 in the later period, of whom all but 222 received WIC benefits. There was a 1.8 percent reduction in the rate of birthweight under 2,500 grams during the first 15 months of WIC operation ($p < 0.05$).

The inclusion of the 222 women who were not enrolled in the WIC program in the WIC sample would tend to underestimate the effect of WIC. However, it was uncertain whether other changes that took place across time might have affected rates of low birthweight or whether criteria for enrollment in the MIC program might have changed after WIC became available.

In another substudy, mean birthweight was compared among all MIC clients in six counties with WIC programs and three counties with similar demographic characteristics but with no WIC programs. The mean birthweight in the WIC counties was 57 grams higher than in the non-WIC counties ($t=2.37$, $p<0.02$). There was little information from which to judge the comparability of the study and control groups.

Mean birthweight was about 100 grams higher among infants of women participating in WIC for more than 1 month compared to those enrolled for 1 month or less. It was unclear, however, whether gestational age was controlled. If not, the result was open to confounding by duration of gestation.

savings, the cost per low birthweight infant and per normal birthweight infant for both WIC and non-WIC deliveries would be needed. Without such data, it remains moot whether the differences in cost were secondary to better health or to the use of less expensive facilities.

Table II-A-24

Schramm (1983)

Population studied	Medicaid births in Missouri, 1980.
Assignment method/ research design	Medicaid recipients linked to WIC records were compared to Medicaid recipients not linked to WIC records.
Study group	
Number	1,883
Treatment	Known WIC recipients
Control group	
Number	5,745
Treatment	Others

Results

Outcome	WIC	Non-WIC	Diff.
% preterm (<37 weeks)	14.5	14.9	-.4
Mean birthweight (g)	3,151	3,145	6
% low birthweight	10.7	12.6	-1.9*
Mean length of infant stay in hospital (days)	4.72	4.92	-.20
Mean length of mother's stay in hospital (days)	3.73	3.81	-.08
Death rate/1,000			
Neonatal	9.4	8.9	.5
Postneonatal	5.8	8.6	-2.8
Infant	15.2	17.5	-2.3

Cost benefit analysis

	Medicaid costs	Other medical costs	Total
Savings per WIC dollar	\$.83	\$.59	\$1.42

No significant difference in rate of pregnancy and labor complications, or congenital malformations.

Comment

- WIC group significantly more rural. Results consistent with WIC rural delivery at less expensive hospitals. Some WIC recipients in control group. No mother's Medicaid record for 25% of births. Deaths under-counted. Sample size too small for secure test of WIC effects on mortality.

* $p < 0.05$.

Table II-A-25 (continued)

Assignment method/ research design	Comparison of birthweight of WIC clients by program participation.	
Study group		
Number	452 (in 6 counties)	
Treatment	MIC plus WIC	
Control group		
Number	222 (in 3 counties)	
Treatment	MIC alone	
Results	Duration of WIC participation (months)	Mean birthweight (g)
	1	3,124 (111)
	2	3,224 (107)
	3	3,222 (80)
	4	3,220 (61)
	5	3,230 (83)
Comment	• Unclear whether gestational age was controlled when comparing birthweight by duration of WIC participation; if not, result confounded.	

* $p < 0.05$.
( ) = n.

Table II-A-25

Sharbaugh et al. (1977)

Population studied	Pregnant women attending North Central Florida Maternity and Infant Care project (MIC) and/or WIC programs (13 counties).
Assignment method/ research design	Comparison of birthweight between 1970-75 (MIC alone) and 1975-76 (MIC plus WIC).
Study group	
Number	2,126
Treatment	MIC plus WIC
Control group	
Number	6,944
Treatment	MIC alone
Results	see below

Birthweight (g)	MIC + WIC	MIC
<2,000	3.7	3.7
2,001-2,500	6.1	7.8
<2,500	9.8	11.6*

Comment	• Later (WIC) group included 222 women who did not enroll in the WIC program.
Assignment method/ research design	Retrospective evaluation of birthweight in 6 WIC counties versus 3 non-WIC counties, with similar demographic characteristics, 1975-76.
Study group	
Number	452 (in 6 counties)
Treatment	MIC plus WIC
Control group	
Number	222 (in 3 counties)
Treatment	MIC alone
Results	Birthweight (g) among MIC enrollees, 1975-76

MIC + WIC	MIC
3,284	3,227

$t = 2.37$, $p < 0.02$

Comment	• Income level of non-WIC counties was higher than WIC counties.

(continued)

Table II-A-26

Silverman et al. (1982)

Population studied	Live singleton deliveries to women enrolled in the Alleghany County, Pa., Maternal and Infant Care (MIC) project, 1971-77.
Assignment method/ research design	Women enrolled in both MIC and WIC between May 1974 and 1977 were compared to controls enrolled only in MIC, either from 1971 through May 1974 (pre-WIC) or later MIC enrollees who did not receive WIC benefits.
Study group	
Number	1,047
Treatment	Prenatal WIC
Control group	
Number	1,204 (1971-May 1974) MIC
Treatment	
Number	337 (May 1974-77) MIC
Treatment	

Results

	WIC	Non-WIC 1971-74	Non-WIC 1974-77	Diff.
Birthweight (g)	3,189	3,102	3,073	
		3,095		94.0***
Adjusted difference[a,b]				95.7**
Adjusted difference[a,c]				39.3(n.s.)
% ≤ 2,500 g	9.7	13.0		-3.3*
Race				
White	7.4	9.3		-1.9
Nonwhite	11.1	15.3		-4.2*
Prepregnant weight (lb)				
≤100	11.5	21.9		-10.4*
101-120	12.7	17.7		-5.0*
Age (years)				
≤15	10.9	12.4		-1.5
16-20	8.4	13.5		-5.1*

Comment

- Events extraneous to WIC could have contributed to changes over time, and thus to differences between WIC recipients and nonconcurrent controls. Current controls may not have been able to register for WIC due to shortened gestation, and may have been less compliant with care or less motivated.

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

[a] n = 1,047 (WIC); n = 1,361 (Non-WIC)

[b] Controlled for prepregnant weight, body mass (kg/m^2), age, race, trimester of MIC admission, number of prior livebirths and low birthweight deliveries and hematocrit and hemoglobin at MIC admission.

[c] In addition, controlled for gestational age, number of prenatal visits, and weight gain.

II-A-26. Silverman, P. R., L. H. Kuller, and D. C. Kolodner. 1982. "The effect of a local prenatal nutrition supplementation program (WIC) on birth weight." Unpublished manuscript. Allegheny County Health Department, Pittsburgh, Pennsylvania.

Silverman et al. (1982) compared 1,047 enrollees in the Maternity and Infant Care (MIC) project in Allegheny County, Pennsylvania, who delivered from May 1974 through 1977 and who were also registered for WIC benefits, with 1,024 MIC enrollees who delivered from 1971 through May 1974 prior to the introduction of WIC, and with 337 later MIC enrollees who were not registered for WIC. Women delivering when WIC was available, but whose WIC status could not be confirmed, were excluded from the analysis. Both sets of controls were combined in analysis since their birthweights were not significantly different (3,102 g from 1971 to 1974; 3,073 g later). The mean birthweight of the WIC group was 3,189 g, 94 grams greater than controls ($p < 0.001$). The rate of birthweight $\leq$2,500 grams was 9.7 percent among WIC recipients and 13.0 percent among controls ($p < 0.02$); the difference associated with WIC was greater among nonwhites (11.1 percent among WIC infants versus 15.3 percent among controls, $p < 0.05$) than among whites (7.4 percent among WIC infants versus 9.3 percent among controls, n.s.). WIC-control birthweight differences were greatest among lightest women (<101 pounds prepregnant weight), among younger women (16 to 20 years old), as well as among women with a history of low birthweight. When birthweight differences were controlled by linear multiple regression analysis for prepregnant weight, body mass (kg/m), age, race, trimester at MIC admission, number of prior livebirths, hematocrit and hemoglobin at MIC admission, and number of prior low-birthweight deliveries, there was no change in the relationship of WIC to birthweight. Further control for duration of gestation, number of prenatal visits, and weight gain in pregnancy reduced the relationship with WIC to 39.3 grams (n.s.). Thus, most of the relationship of WIC with birthweight was mediated by weight gain, number of prenatal care visits, and duration of gestation.

Selection bias was possible. Nonparticipants in WIC during the period when WIC was available might not have registered for WIC because of preterm delivery; if the pregnancy had been longer, they would have had greater opportunity to enroll. This is consistent with the observation that there was no difference between the WIC and control groups in the rate of low birthweight among women delivering at term (<36 weeks). Also, there has been a national trend to lower rates of low birthweight (Kessel and Villar, 1983). Thus, decreasing rates in this study may be, in part, due to changes in time independent of the WIC program and cannot be securely ascribed to effects of the WIC program, although the authors employed sophisticated multiple regression techniques to adjust for differences in identifiable characteristics between WIC recipients and controls.

recipients (1.1 percent, $p < 0.05$; for whites, 1.9 percent, $p < 0.05$). Blacks who received WIC had significantly fewer complications of labor than black controls (-3.4 percent, $p < 0.05$). There were no significant differences in the Apgar score. These results strongly suggest that women enrolled in WIC were at initially higher risk than the residual (control) population.

The relationship of WIC receipt to birthweight was stratified by value of vouchers redeemed (<$75, $75 to $150, >$150) and adjusted for gestational age. Differences between WIC recipients and controls were confined to those redeeming over $150 worth, or about 5 months, of vouchers. The authors concluded that length of participation in WIC was significantly related to birthweight. Voucher redemption might be partially confounded by behavioral factors, which may be associated with improved birth outcome. Control for duration of gestation was probably done categorically (this was not specified) with each category covering a wide range of gestational ages (e.g., 37 to 42 weeks); thus, gestational age was probably underadjusted. In addition, duration of gestation is difficult to measure with great accuracy. Therefore, controlling for measured gestation cannot fully remove the effect of longer gestation, in turn, leading to greater opportunity to redeem more vouchers. Thus, while inference on the effects of variation in duration of benefits must be cautious, the argument is reasonably convincing.

When analysis was restricted to births to high-risk mothers (interpregnancy interval less than 18 months, age under 18 or over 34 years, more than four previous pregnancies, previous bad outcome, medical complications [e.g., diabetes], multiple pregnancy, or $\leq$10 percent underweight or $\geq$20 percent overweight for height), mean birthweight was significantly higher with WIC (50 g, $p < 0.05$) with almost all the difference contributed by nonwhites (177 g, $p < 0.05$). The nonwhite difference was due to large differences in the subgroups that either had medical complications (171 g, $p < 0.05$) or were over 34 years old (390 g, $p < 0.05$); there were, however, only 48 nonwhite women over 34 years of age in the WIC group.

The use of prepregnant weight, education, and race as the only control variables may have resulted in under-control, and the mean birthweight and the difference of 16 grams would then be an underestimate. On the other hand, this study stands out for its sophisticated analysis and the large number of subjects.

The Missouri linked birth, fetal, and infant death data set is probably the most extensive in the country and includes maternal smoking, a rarity. The use of smoking as a control variable removed any possible effect of WIC mediated by reduction of smoking. It might be instructive to treat smoking as both an intervening and an interacting variable, to judge whether WIC effects were greater among smokers or mediated by reduction in smoking.

II-A-27. Stockbauer, J., and C. R. Blount. 1983. "Evaluation of the prenatal participation component of the Missouri WIC program." Missouri Department of Social Services, Division of Health, Jefferson City, Missouri.

Stockbauer and Blount (1983) compared birth outcome of prenatal WIC recipients in Missouri in 1980 with that of nonparticipants in three different ways: first, versus all non-WIC births in 1980, by directly adjusting for differences in prepregnancy weight, smoking, race, and education; second, versus randomly selected nonparticipants, controlling by analysis of covariance for differences in the same characteristics and, in addition, gravidity, infant sex, pregnancy spacing, complications of pregnancy, labor, and delivery, complications not related to delivery, and a second-order term for prepregnancy weight; and third, with a subset of nonparticipants chosen by matching on "key variables" (not specified but probably the same variables as in the first analysis). Because analysis of covariance assumes no interaction with the control factor and because 16 percent of the WIC group was not matched in the pair-matching procedure, most results presented were those from direct adjustment. Mean birthweight and the proportion of low-birthweight infants were similar by the other two analytic methods.

After removing records of women who were known to have moved out of State, who delivered other than in 1980, who were not pregnant, or who had induced or spontaneous abortions, 7 percent of the residual pregnant WIC participants could not be linked to birth or fetal death certificates. Thus, some women who were on the WIC roster but who could not be linked to vital records were included in the control group. Whether women who were either not compliant with the program or who did not return for WIC vouchers because of premature delivery were retained in the WIC group was not specified.

The birthweight difference associated with WIC was small but significant (16 g, $p < 0.05$), and was larger among nonwhites (48 g, $p < 0.05$). There was an overall 0.9 percent lower rate of low birthweight in the WIC group (8.5 vs. 9.4 percent, $p < 0.05$); the difference for nonwhites was 3.1 percent (11.2 vs. 14.3 percent, $p < 0.05$). Gestational age was significantly longer in the WIC group (0.36 weeks, $p < 0.05$); for whites, 0.11 weeks ($p < 0.05$) and for blacks, 0.30 weeks ($p < 0.05$). The rate of preterm delivery (<37 weeks) was lower in the WIC group; 0.7 percent lower for whites, 7.9 vs. 8.6 percent (n.s.), and 2.6 percent lower for blacks, 14.0 vs. 16.6 percent ($p < 0.05$).

Perinatal death was significantly greater for the WIC recipients among whites, but significantly lower among blacks. The pattern for infant mortality was similar but not significant. A significantly lower proportion of WIC participants received adequate prenatal care (-3.3 percent, $p < 0.05$). This difference was contributed entirely by whites (-4.0 percent, $p < 0.05$). Complications of pregnancy were more common among WIC

Table II-A-27 (continued)

Results

(Group (a), direct adjustment method[a])

Outcome	Total WIC	Total Non-WIC	Total Diff.	White WIC	White Non-WIC	White Diff.	Nonwhite WIC	Nonwhite Non-WIC	Nonwhite Diff.
Birthweight (g):									
Mean	3,254	3,328	16*	3,325	3,326	-1.0	3,116	3,068	48*
% < 2,500 g	8.5	9.4	-.9*	7.1	6.8	.3	11.2	14.3	-3.1*
Gestation (weeks):									
Mean	39.83	39.47	.36*	40.13	40.02	.11*	39.26	38.96	.30*
% small for gestational age	6.3	6.3	0	5.6	4.9	.7	7.8	9.2	-1.4*
% <37	10.5	10.9	-.4	8.6	7.9	.7	14.0	16.6	-2.6*
Mortality/1,000:									
Perinatal	20.7	20.2	.5	21.4	15.9	5.5*	19.3	28.8	-9.5*
Infant	16.3	16.1	.2	15.8	13.0	2.8	17.2	21.8	-4.6
% adequate prenatal care	67.2	70.5	-3.3*	67.2	71.2	-4.0*	67.2	68.1	-.9
% complications of pregnancy	9.2	8.1	1.1*	8.8	6.9	1.9*	9.8	10.5	-.7
% complications of labor	21.5	22.6	-1.1	22.3	22.2	.1	19.8	23.2	-3.4*
Women at risk[b] (in WIC = 3,675)									
Mean birthweight	3,231	3,181	50 g*	3,306	3,315	-9 g	3,099	2,922	177 g*
% low birthweight	10.2	11.4	-1.2*	8.7	8.7	0	12.9	16.7	-3.8*

Comment

- WIC group probably worse off even after controlling for prepregnant weight, smoking, education and race. Reduction in smoking could have mediated some effect of WIC, but cannot be judged from this analysis. Cost of voucher redemption is probably a confounded measure of duration of WIC participation. Not specified if women terminated from WIC program retained in analysis.

* $p < 0.05$.

[a] Adjusted for race, prepregnancy weight, smoking and education.

[b] Interpregnancy interval <18 months, age <18 or >34 y, 4+ previous pregnancies, previous bad outcome, medical complication, multiple pregnancy, $\geq$ 10% underweight or $\geq$ 20% overweight for weight.

Table II-A-27

Stockbauer and Blount (1983)

Population studied	All births in Missouri, 1980.
Assignment method/ research design	Births to prenatal WIC participants compared to (a) all births to nonparticipants, controlled by direct adjustment for prepregnant weight, smoking, race, and education; (b) an equal number of randomly selected nonparticipants, controlled by analysis of covariance for all variables in (a) plus gravidity, sex, pregnancy spacing, complications of pregnancy, labor, and delivery and not related to pregnancy, and prepregnant weight squared; and (c) pair matching on the same variables as in (a). All outcomes were reported for method (a).
Study group	
Number	(a) 6,657
Treatment	Prenatal WIC receipt
Number	(b) 6,560
Treatment	Prenatal WIC receipt
Number	(c) 5,574
Treatment	Prenatal WIC receipt
	(Approximately 65% white, 34% nonwhite)
Control group	
Number	(a) 71,931
Treatment	All non-WIC births
Number	(b) 6,560
Treatment	Random sample of non-WIC births
Number	(c) 5,574
Treatment	Matched non-WIC births

(continued)

Table II-A-28

Weiler et al. (1979)

Population studied	Infants certified November 1976-September 1977 in WIC programs in Fayette County, Kentucky, because of nutritional anemia. Hemoglobin measured at recertification (median age: 59 days) and recertification (median age: 230 days).
Assignment method/ research design	Pre-post comparison.
Study group	
Number	37
Treatment	Infants certified for WIC because of anemia, with repeated measurement at recertification.
Control group	
Number	None
Treatment	--
Results	Mean change in hemoglobin at recertification (g/dl)

Age at certification		
<6 weeks	2.9	(9)
6 weeks-6 months		
Initial value > expected	-.5	(11)
Initial value < expected	1.0	(17)
Total	1.0	
% increasing	73	
Assumption of no change expected	p = 0.0009	

Comment

- Repeated measurements for only 37 of 311 infants certified because of nutritional anemia were available at recertification.
- Observed results consistent with regression to the mean.

( ) = n.

II-A-28. Weiler, P. G., H. P. Stalker, S. W. Jennings, and W. T. Fister. 1979. "Anemia as a criterion for evaluation of a Special Supplemental Food Program for Women, Infants, and Children." Pediatrics 63:584-590.

Weiler et al. (1979) studied infants admitted into WIC programs in Fayette County, Kentucky, because of nutritional anemia from November 1976 to September 1977. Only the 37 infants (of 311) who were recertified and therefore had two hemoglobin values were included.

Change in hemoglobin was reported between age at certification (median, 59 days) and recertification (median, 230 days). Change was calculated by:

$$\begin{pmatrix}\text{Observed hemoglobin} \\ \text{at recertification}\end{pmatrix} - \begin{pmatrix}\text{observed hemoglobin} \\ \text{at certification}\end{pmatrix} - \begin{pmatrix}\text{Expected hemoglobin for} \\ \text{age at recertification}\end{pmatrix} - \begin{pmatrix}\text{expected hemoglobin at} \\ \text{age of certification}\end{pmatrix}.$$

The mean change in hemoglobin for all 37 children ranged from -2.9 to +6.1 grams per deciliter (g/dL) with an average of +1.0 g/dL. Of the 37 children, 73 percent had a positive change, 22 percent had a negative change, and 5 percent had no change. On the assumption of no expectation in change in hemoglobin values, the number of children with a positive change was significant ($p = 0.0009$). However, this assumption is undermined by likely regression to the mean, which would account for some increase in observed values.

Of the 28 children certified between ages 6 weeks and 6 months of age, 23 were within 1.0 g/dL of the expected value, and of these, 11 had hemoglobin values greater than or equal to expected values at recertification. For these 11 infants, the average change in hemoglobin was -0.5 g/dL. The 17 infants with hemoglobin values below that expected at certification had an average change of +1.0 g/dL.

Nine infants had been certified before 6 weeks of age. All had hemoglobin values lower than expected. The average change in hemoglobin for these infants was +2.9 g/dL.

This small study was uncontrolled. The extent that higher (or lower) values at recertification were due to regression to the mean, therefore, could not be quantified. Also, the very small number of children returning for recertification calls into question how representative they were of the total group treated.

The authors calculated monthly program costs. Monthly cost per infant decreased each month from $55.26 in November 1976 to $27.61 in September 1977.

Table II-A-29

Williams (1982)

Population studied	Participants in Wyoming WIC Program, 1978-80.
Assignment method/ research design	Comparison of birth records between prenatal and postnatal WIC results.
Study group	
Number	211
Treatment	WIC benefits for less than 3 months
Number	295
Treatment	WIC benefits for 3 or more months
Control group	
Number	750
Treatment	Postnatal WIC recruits

Results

Birthweight <2,500 grams (%)

Racial group	Prenatal WIC: Duration of benefits (months) <3	Prenatal WIC: Duration of benefits (months) ≥3	Prenatal WIC: Total	Postnatal WIC	Total
White	16.2 (148)	8.4 (202)	11.7	13.9 (588)	13.1
Hispanic	4.4 (45)	3.3 (59)	3.8	15.3 (111)	9.8
Other	0.0 (18)	5.9 (34)	3.9	17.6 (51)	10.7
Total	12.3	7.1	9.3	14.4**	12.3

Comment

- Results by duration of treatment confounded by duration of gestation. Control group (postnatal WIC recruits) probably biased to include excess preterm delivery; postpartum certification may have been due to low birthweight.

** $p < 0.01$.
( ) = n, denominator.

II-A-29. Williams, J. T. 1982. "Wyoming WIC Evaluation." Unpublished letter to Food and Nutrition Service.

Williams (1982) described an assessment of the WIC program in Wyoming from 1978 to 1980 in a letter to the Department of Agriculture. He studied the impact of WIC on outcome of pregnancy among high-risk women, whether the WIC program was functioning as an integral component of health care, and the needs of the population served. Rates of low birthweight of infants of mothers who participated in the WIC program for 3 months or more (n=295), less than 3 months (n=211), and who were recruited into the WIC program postpartum (n=750), were 7.1 percent, 12.3 percent, and 14.4 percent, respectively. The comparability of study and control groups was uncertain. The control group of postnatal WIC recruits was likely to have been at higher risk than the prenatal WIC recipients. Comparisons by duration of WIC benefits were subject to confounding by duration of gestation, and there was bias towards short gestation among the control group, since some control women might have enrolled in WIC during pregnancy if they had not delivered prematurely. In addition, postpartum recruitment might have been due to low birthweight and/or prematurity.

Monthly computerized reports of referrals made by the WIC staff for immunization services and to well-child clinics, prenatal classes, private physicians, and other health care services were reviewed to assess integration within the WIC program.

Results were preliminary and are not yet available in a formal report or publication.

II-B-1. Argeanas, S., and I. Harrill. 1979. "Nutrient intake of lactating women participating in the Colorado WIC Program." Nutrition Reports International 20(6):805-810.

Argeanas and Harrill (1979) compared the dietary intake of lactating women in Fort Collins, Colorado, eleven enrolled in the WIC program and five controls, within 6 weeks postpartum and 2 months after the initial interview. Height and weight were measured at both interviews. The caloric intake of WIC participants increased by 310 kilocalories, or from 69 to 81 percent of the normative level for pregnant women set by the Food and Nutrition Board of the National Academy of Sciences (2,400 kcal), over the 2-month period, while controls reduced caloric intake from 97 to 94 percent of the same normative level. Though WIC recruitment criteria were not specified, the study women may have been recruited based on inadequate nutritional patterns, such as low caloric intake. Thus, this increase could, in part, have been due to regression to the mean. The mean intake of all measured nutrients except Vitamin C increased in WIC participants. Mean body weight declined by 2.1 and 1.6 kilograms among WIC and non-WIC women, respectively.

The sample was small and the control and study groups were not comparable; controls had higher mean income. Actual income and other demographic data were not reported.

Appendix II-B: Individual review of studies, primarily addressing issues other than health effects of the WIC program.

These detailed reviews are presented as a matter of record, even though they do not relate centrally to health outcome.

II-B-2. Bendick, M., T. H. Campbell, D. L. Bowden, and M. Jones, The Urban Institute. 1976. "Efficiency and effectiveness in the WIC program delivery system." Miscellaneous Publication No. 1338, 1-216. U.S. Department of Agriculture.

Bendick et al. (1976) of the Urban Institute conducted a study at 96 randomly sampled WIC clinics in 60 program areas across the country. The sample was stratified by the size of the population served, region of the country, and system of WIC food distribution. The study used interviews and self-completed questionnaires by clinic staff to ascertain characteristics of WIC programs and participants. In addition, active and former WIC participants and a small sample of nonparticipants were interviewed. The data from the control sample were analyzed and reported separately.

The study described services provided by WIC clinics and client satisfaction with these services. About 96 percent of WIC participants were satisfied with the way they received WIC foods. About 65 percent of sample clinics used retail purchase for food distribution. Not surprisingly, dissatisfied participants had higher costs, experienced greater inconvenience in getting to WIC clinics, and had difficulty in arranging child care. Number of visits for preventive health services (estimated by clinic staff, not counted from records or estimated by clients) was greater among pregnant women receiving WIC (5.8 vs. 5.1 visits among non-WIC women [n.s.]). The estimated number of well-infant visits during the first 6 months and between the first and fourth birthdays was greater for WIC recipients (for infants, 3.8 vs. 3.0 in the non-WIC group ($p < 0.001$); for children, 3.9 vs. 2.2 for non-WIC children [$p < 0.001$]). Nutrition counseling was given in about 70 percent of clinics in 1975, with only 12 percent of WIC participants judging that they had learned something.

Effectiveness of WIC services was judged from estimates by WIC clinic administrators and current and former WIC participants, but without a comparable control sample.

Table II-B-1

Argeanas and Harrill (1979)

Population studied	Lactating women in Fort Collins, Colorado, 1978.
Assignment method/ research design	Twenty-four hour dietary recall, demographic and other information (maternal eating habits, infant feeding practices, etc.) collected within 6 weeks of delivery and 2 months later.
Study group	
Number	11
Treatment	WIC
Control group	
Number	5
Treatment	None (middle income)
Results	

Mean intake and % RDA

	WIC				Controls			
	Weeks postpartum							
	0-6		8-15		0-6		8-15	
	Mean intake	% RDA	Mean intake	% RDA	Mean intake	% RDA	Mean intake	% RDA
Energy (kcal)	1,729	69	2,039	81	2,438	97	2,356	94
Protein (g)	87.1	131	101.1	153	118.0	179	99.6	151
Calcium (mg)	980	82	1,003	84	1,801	150	1,382	115
Iron (mg)	13.4	74	15.2	84	15.3	85	15.7	87
Vitamin A (IU)	3,749	62	8,616	144	6,391	106	6,799	113
Thiamin (mg)	1.03	79	1.37	105	1.34	103	1.22	94
n	11		11		5		5	

Comment

• Controls had higher income than study group.

II-B-3. Christie, D. D., and L. B. Gale. 1979. "WIC program involvement in the prevention of mental retardation." Mimeograph. New Jersey State Department of Health, John Fitch Plaza, Trenton, New Jersey.

Christie and Gale (1979) described results of the New Jersey Nutrition Surveillance Program from July 1977 to June 1979 and proposed improvements in the WIC program.

The prevalence of low hematocrit (<31 or <34 percent for children 0 to 23 months and 2 to 5 years of age, respectively) in three community clinics ranged from 14.8 to 31.6 percent. Thus, the WIC program served children with a high rate of anemia. Many of the children in two of the clinics were also growth retarded (rates were not specified).

While the prevalence rates for anemia among WIC participants were high, no conclusions on the effectiveness of WIC services could be drawn from this study.

Table II-B-3

Christie and Gale (1979)

Population studied	Infants and children participating in 3 New Jersey WIC programs.
Assignment method/ research design	--
Study group	
Number	575, Site: North Camden 197, Site: South Camden 928, Site: Plainfield
Treatment	WIC
Control group	
Number	None
Treatment	--
Results	Hematocrit <31% for children 0-23 months of age or <34% at 2-5 years of age, respectively. North Camden 31.6% South Camden 15.3% Plainfield 14.8% WIC population had low weight and height for age, low weight for height and increased weight for height >95th percentile.

Table II-B-2

Bendick et al. (1976)

Population studied	Current and former WIC participants and staff in 96 WIC clinics in 30 states in operation between 1974 and 1975.
Assignment method/ research design	Stratified random sample of WIC clinics by geographical area, size of caseload, rural vs. urban location, ethnic group served and diversity of procedures and policies within programs. Structured interviews with administrators and current and former WIC clients.
Study group	
Number	3,149
Treatment	Current WIC participants
Number	448
Treatment	Former WIC participants
Control group	
Number	None
Treatment	--
Results	Number of visits for preventive health care

	WIC[a]	Non-WIC[a]
Women[b]	5.8 (72)	5.1 (72)
Infants[c]	3.8 (90)	3.0*** (87)
Children[d]	3.9 (85)	2.2*** (78)

81% (2,855) of WIC households were using WIC foods in preparing family meals.

*** $p < 0.001$.
( ) = n of clinics.

[a]Estimates reported by 96 WIC Clinic Administrators of WIC participants and "comparable non-WIC" clinic users.

[b]Women: Total number of prenatal visits per pregnancy.

[c]Infants: Number of visits to well-child clinics during first 6 months.

[d]Children: Number of visits of well-child clinics between 1st and 4th birthdays.

Table II-B-4

Comptroller General of the United States, (1979)

Population studied	Local WIC programs and individuals in Illinois, Louisiana, New York and Washington.
Assignment method/ research design	Review of records. Visits to WIC sites.
Study group	
Health services analysis:	
Number	20 WIC sites 500 WIC recipients
Certification criteria:	
Number	76 WIC recipients
Nutritional assessment:	
Number	125 WIC recipients
Treatment	WIC
Control group	
Number	None
Treatment	--
Results	

Health services

	Available/ received (%)
Health services available at site, or by agreement with outside source	70.0
Health services received by individuals[a]	86.5

Nutritional risk assessment (%)

	No assessment	Improper certification
Washington	60 (125)	9 (51)
Louisiana	NA	20 (25)

Comment

- Methods of selection of states, clinic sites, and individuals not reported.

( ) = n.

[a]Data unavailable for 107 cases.

II-B-4. Comptroller General of the United States (1979). "The Supplemental Food Program for Women, Infants, and Children (WIC)--How can it work better?" Washington, D.C.: United States General Accounting Office.

The Comptroller General's Report (1979) is a description of several components of the WIC program at sites in Illinois, Louisiana, New York, and Washington. Information was obtained from visits and reviews of State and local WIC agencies and from reviews of records of individual participants. The report focuses on weaknesses of implementation of the program, not outcome or effects, and recommends ways to improve the program. Program elements reviewed were integration with health care, nutritional risk assessment, composition of food packages, nutrition education, and the need for evaluation of the program.

Although much of the information in the report is qualitative, there was a review of available health services at 20 WIC sites (how the sites were chosen is not specified). Six did not provide either prenatal or pediatric services, either at the site or by contract with outside agencies. It was not, however, indicated whether these six sites served both prenatal and childhood WIC clients. Some 500 individuals were chosen for record review (the method for selection was not stated), but 107 charts were not found. Of the other 393 individuals, 86.5 percent received health care services and 13.5 percent did not.

Criteria of nutritional risk varied by State. For instance, risk for anemia was defined in Illinois as hemoglobin under 13 grams-percent (g-percent), in Louisiana, under 11 g-percent; in New York, under 12 g-percent; in the Seneca Indian Nation, under 12 g-percent; and in Washington, under 11.5 g-percent.

Whether WIC nutritional risk criteria were met by recipients was assessed in Washington and Louisiana. In Washington, records of 51 participants at three clinics were reviewed. Five participants (9 percent) did not meet the State's nutritional risk criteria. In Washington, 125 records were selected at five clinics. The required nutritional risk assessments were only made in 60 percent of those cases. In Louisiana, five of 25 records reviewed at one clinic showed "improper" certification.

Table II-B-5

Drayton (1982)

Population studied	First 25 high risk pregnant women who were certified eligible for WIC benefits in three centers in Illinois, 1981.
Assignment method/ research design	Twenty-four hour dietary recall and nutrition knowledge questionnaire given at WIC certification and 6-8 weeks postpartum or at recertification.
Study group	
Number	75
Treatment	WIC
Control group	
Number	None
Treatment	
Results	Significance of post-test scores, controlled for pretest score, by analysis of covariance

	Background of nutrition educator	Time spent receiving nutrition education
Knowledge of		
Milk/vitamin D/calcium	*[a]	NA
Caloric intake	*[b]	*[b]

No significant relationships with knowledge of general nutrition, intake of Vitamin C, iron, Vitamins A, B12, B6, C, and D, iron, protein, calcium and folacin or with hematocrit.

Type of nutrition education defined as basic contact, basic + secondary contact, or basic + secondary + high risk contact, unrelated to outcome.

Comment • Sample sizes were small; no control group.

*$p < 0.05$ ($n = 77$).

[a]Knowledge significantly greater if counseled by nutrition aide vs. registered dietician or graduate student.

[b]Caloric intake higher if counselor was registered dietician, and with increased duration of nutrition education.

II-B-5. Drayton, P. K. D. 1982. "An evaluation of the women, infants, and children nutrition education intervention program for high risk pregnant women in three centers of Illinois." Doctoral thesis. Southern Illinois University at Carbondale, Illinois.

Drayton (1982) studied 25 pregnant women at each of three WIC centers in Illinois at the time of WIC certification and again at 6 to 8 weeks postpartum or at recertification, from 1979 to 1981. The Nutrient Dietary Data Analysis form (based on a 24-hour dietary recall) and a nutrition knowledge questionnaire (developed by the author) were used. WIC records were reviewed for hematocrit level and extent and type of nutrition education. Postpartum hematocrit levels, the percentage of the RDA consumed for specific nutrients, and nutrition knowledge scores were analyzed by the effects of various types of nutrition education methods (basic contact only, basic plus secondary contact, or basic plus secondary plus high-risk contact), the background of educators (registered dietician, food and nutrition graduate student, or nutrition aide), and varying lengths of time spent on education.

Postpartum test scores were controlled for prepartum scores. Postintervention nutrition knowledge was significantly greater for milk/Vitamin D/calcium, one of five categories, if the nutrition educator was a nutrition aide. The type of information provided and the time spent by education were not related to changes in nutrition knowledge. Postintervention hematocrit levels did not vary as a function of the background of the educator, nor the type or extent of education. Caloric intake was significantly greater with increased duration of education and when the nutrition educator was a registered dietician. There were no other significant relationships to reported intake.

Sample sizes were small, and there was no control group. Only postintervention hematocrit levels were presented.